



Columbia River System Operations Final Environmental Impact Statement

Appendix E

Fish, Aquatic Macroinvertebrates, and Aquatic Habitat

Note: The Section 508 amendment of the Rehabilitation Act of 1973 requires that the information in federal documents be accessible to individuals with disabilities. The Agency has made every effort to ensure that the information in Appendix E: Fish, Aquatic Macroinvertebrates, and Aquatic Habitat for the Columbia River System Operations Environmental Impact Statement is accessible. However, if readers have any issues accessing the information in this appendix, please contact the U.S. Army Corps of Engineers at (800) 290-5033 or info@crso.info so additional accommodations may be provided

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CHAPTER 1 - METHODS AND MODELS

1.1 INTRODUCTION

This appendix describes the methods and models used to determine effects of alternatives considered on fish and aquatic resources in the Columbia River System Operations (CRSO) Environmental Impact Statement (EIS).

1.1.1 Methods

A variety of methods were employed to evaluate effects of alternatives on fish and aquatic resources. These include regionally approved models, application of accepted relationships, use of surrogate species, and qualitative evaluations. Effects analyses were broken into three broad groups – anadromous fish, resident fish, and aquatic macroinvertebrates.

1.1.1.1 Anadromous Fish

A total of 18 anadromous species or Evolutionarily Significant Units (ESUs) were evaluated as part of the EIS. Tools used in the analysis of effects of alternatives on these species included models, surrogate comparisons, and qualitative analysis. Models were used to quantify effects to four species (Table 1-1). These models include the Comparative Survival (COMPASS) model for juvenile downstream migration and survival, National Oceanic and Atmospheric Administration (NOAA) Life Cycle models for adult upstream migration and survival, Comparative Survival Study (CSS) models for both juvenile downstream and adult upstream migration and survival, and a total dissolved gas (TDG) model for evaluating effects of gas supersaturation. Each of these models will be discussed below in the models section.

Anadromous species that did not have suitable models to predict effects of alternatives were evaluated using both qualitative analyses and surrogate extrapolation. Surrogate methodology uses the outputs from modeled species to provide insights into the effects of alternatives on other species with similar life histories and habitats. Where an appropriate model or surrogate was not available, a qualitative evaluation of hydrology and water quality data was used to evaluate changes to the environmental factors important to the life stages of fish species, as illustrated by the Concept Evaluation Models (CEMs). Table 1-1 shows the methods used for evaluating each of the anadromous species analyzed within this EIS.

Table 1-1. Primary evaluation methods used to evaluate each anadromous species

Species/ESU/DPS	Analysis Methods
Upper Columbia River Spring-Run Chinook Salmon	COMPASS, NWFSC Life Cycle Model (Wenatchee Population), TDG Tool, CEM, Qualitative
Upper Columbia River Steelhead	COMPASS, TDG Tool, CEM, Qualitative
Upper Columbia River Coho Salmon	UC Spring Chinook surrogate, CEM, Qualitative
Columbia River Sockeye Salmon	UC Spring Chinook surrogate, CEM, Qualitative
Upper Columbia Summer/Fall Chinook Salmon	CEM, Qualitative
Middle Columbia Spring-Run Chinook salmon	UC Spring Chinook surrogate, CEM, Qualitative

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Species/ESU/DPS	Analysis Methods
Middle Columbia Steelhead	UC Spring Chinook surrogate, CEM, Qualitative
Snake River Spring/Summer Chinook Salmon	COMPASS, CSS cohort model, NWFSC Life Cycle Model (Upper Salmon, South Fork Salmon, and Middle Fork Salmon MPGs), CSS Life Cycle Model (Grande Ronde/Imnaha MPG) TDG Tool, CEM, Qualitative
Snake River Steelhead	COMPASS, CSS cohort model, CSS Life Cycle Model (Grand Ronde/Imnaha MPG), TDG Tool, CEM, Qualitative
Snake River Coho Salmon	Snake River Spring Chinook Salmon Surrogate, CEM, Qualitative
Snake River Sockeye Salmon	Snake River Spring Chinook Surrogate, CEM, Qualitative
Snake River Fall Chinook Salmon	CEM, Qualitative
Lower Columbia Spring Chinook Salmon	Snake River Spring/Summer-Run Chinook Salmon Surrogate, CEM, Qualitative
Lower Columbia Steelhead	Snake River Steelhead Surrogate, CEM, Qualitative
Lower Columbia River Coho Salmon	Snake River Spring Run Chinook Salmon Surrogate, CEM, Qualitative
Chum Salmon	Snake River Spring Run Chinook Salmon Surrogate, CEM, Qualitative
Pacific Eulachon	CEM, Qualitative
Green Sturgeon	CEM, Qualitative
Pacific Lamprey	CEM, Qualitative
American Shad	Qualitative

1.1.1.2 Resident Fish

All resident fish were evaluated during workshops to qualitatively assess changes to the important relationships described by the CEMs and considered local knowledge of how fish species interact with their environment and one another at the fish community level. Effects to resident fish were analyzed by eight subbasin teams using predicted metrics, such as water flow, elevation, temperature, and DO. Where possible, relationships between these metrics and biological metrics were used to quantify expected changes to habitat elements, such as productivity, the number of resident fish that are swept downstream past the dams due to flows (i.e., entrainment), and habitat losses based upon existing literature or local information. Where quantitative data could not be generated, qualitative analyses were completed using existing literature and expert knowledge from local managers.

1.1.1.3 Macroinvertebrates

Consistent data regarding macro-invertebrate habitats and populations in the Columbia River Basin are lacking. To analyze the effects of Multiple Objective Alternatives (MOs) to these resources, the teams used existing literature to compare expected outcomes from the MOs using the hydrology and water quality modeling outputs, similar to resident fish analyses.

1.1.1.4 Workshops

Multiple full-day effects analysis workshops were held from January through June 2019 (Table 1-2). Participants included fish experts from the three co-lead agencies and many cooperating agencies.

Table 1-2. Full List of CRSO EIS Fish Team Meetings Supported by Triangle Associates

Meeting Title	Meeting Date	Meeting Location	Number of Meetings
Anadromous Fish Team Bi-Weekly Calls	June 29, 2018– June 14, 2019	Webinars	23
Resident Fish Team Bi-Weekly Calls	June 27, 2018– July 10, 2019	Webinars	20
Upper River Anadromous Species Effects Analysis (No Action Alternative)	January 24, 2019	Boise, ID	1
Lower River Anadromous Species Effects Analysis (No Action Alternative)	January 29, 2019	Ridgefield, WA	1
Lamprey Effects Analysis (No Action Alternative)	January 30, 2019	Portland, OR	1
Eulachon & Sturgeon Effects Analysis (MO1/MO4)	March 28, 2019	Portland, OR	1
Coho & Chum Effects Analysis (MO1/MO4)	March 29, 2019	Portland, OR	1
Lamprey Effects Analysis (MO1/MO4)	April 2, 2019	Walla Walla, WA	1
Upper River Anadromous Species Effects Analysis (MO1/MO4)	April 3 – 4, 2019	Walla Walla, WA	2
Eulachon & Sturgeon Effects Analysis (MO2/MO3)	April 22, 2019	Ridgefield, WA	1
Coho & Chum Effects Analysis (MO2/MO3)	April 23, 2019	Portland, OR	1
Lamprey Effects Analysis (MO2/MO3)	May 21, 2019	Boise, ID	1
Upper River Anadromous Species Effects Analysis (MO2/MO3)	May 22 – 23, 2019	Boise, ID	2
Resident Subgroup Lead Meetings	August 23, 2018 October 19, 2018 December 11, 2018	Walla Walla, WA Webinar Portland, OR	3
Kootenai Resident Subgroup Effects Analysis (No Action Alternative)	January 16, 2019	Bonniers Ferry, ID	1
Upper Columbia River (Canada to Chief Joseph) Resident Subgroup Effects Analysis (No Action Alternative)	January 31, 2019	Spokane, WA	1
Middle Columbia (McNary to Bonneville) Resident Subgroup Effects Analysis (No Action Alternative)	February 14, 2019	Portland, OR	1
Pend Oreille Resident Subgroup Effects Analysis (No Action Alternative)	February 28, 2019	Coeur d’Alene, ID	1
Kootenai Resident Subgroup Effects Analysis (No Action Alternative) Follow-Up Webinars	March 13, 2019 March 28, 2019 April 30, 2019	Webinars	3
Upper Columbia River (Chief Joseph to McNary) Resident Subgroup Effects Analysis (No Action Alternative)	March 14, 2019	Wenatchee, WA	1

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Meeting Title	Meeting Date	Meeting Location	Number of Meetings
Lower Columbia River (Below McNary) Resident Subgroup Effects Analysis (MO1/MO4)	April 8, 2019	Portland, OR	1
Snake River Resident Subgroup Effects Analysis (MO1/MO4)	April 9, 2019	Walla Walla, WA	1
Upper Columbia River (Canada to Chief Joseph) Resident Subgroup Effects Analysis (MO1/MO4)	April 10, 2019	Spokane, WA	1
Pend Oreille Resident Subgroup Effects Analysis (MO1/MO4)	April 11, 2019	Spokane, WA	1
Upper Columbia River (Chief Joseph to McNary) Resident Subgroup Effects Analysis (MO1/MO4)	April 18, 2019	Webinar	1
Snake River Resident Subgroup Effects Analysis (MO2/MO3)	May 16, 2019	Walla Walla, WA	1
Clark Fork Resident Subgroup Effects Analysis (MO1/MO2/MO3/MO4)	May 30-31, 2019	Kalispell, MT	2
Upper Columbia River (Canada to Chief Joseph) Resident Subgroup Effects Analysis (MO2/MO3)	June 5, 2019	Spokane, WA	1
Anadromous Fish Modeling Meeting	July 18, 2018	Webinar	1
Anadromous Fish Modeling Meeting	August 28-29, 2018	Seattle, WA	1
Anadromous Fish Modeling Meeting	September 27, 2018	Seattle, WA	1
Anadromous Fish Modeling Meeting	October 25-26, 2018	Walla Walla, WA	1
Anadromous Fish Modeling Meeting	December 17-18, 2018	Seattle, WA	1
Anadromous Fish Modeling Meeting	March 19, 2019	Portland, OR	1
Anadromous Fish Modeling Meeting	April 29, 2019	Portland, OR	1
Anadromous Fish Modeling Meeting	May 29, 2019	Portland, OR	1
Clark Fork NEPA Mitigation Meeting	May 31, 2019	Webinar	1
Mitigation Planning Call	June 4, 2019	Webinar	1
UC CAN-CHJ NEPA Mitigation Meeting	June 5, 2019	Webinar	1
Lower Columbia River NEPA Mitigation Meeting	June 11, 2019	Webinar	1
Lamprey NEPA Mitigation Meeting	June 11, 2019	Webinar	1
Upper Columbia River NEPA Mitigation Meeting	June 17, 2019	Webinar	1
Pend Oreille Kootenai NEPA Mitigation Meeting	June 17, 2019	Webinar	1
Snake River NEPA Mitigation Meeting	June 20, 2019	Webinar	1
NEPA Compliance Team Call with Fish Technical Team	November 6, 2018	Webinar	1

1.1.1.5 Powerhouse Surface Passage

All four MOs contained measures to improve downstream fish passage by installing or using existing Powerhouse Surface Passage Structures at one or more Federal Columbia River Power System (FCRPS) projects. To evaluate the effects of these structures on fish populations, modelers need an estimate of the effectiveness of these structures in diverting migrating fish that historically passed through powerhouses to new surface passage routes.

A number of studies have looked at surface passage throughout the FCRPS under a wide variety of environmental and operational conditions (Johnson et. al. 2007, Krcma et al. 1982, Ploskey et. al. 2007, Ploskey et al. 2012, Ploskey et al. 2012a, and Swan et. al. 1997). These studies reported varied results. The sluiceways at Bonneville, The Dalles, and Ice Harbor are most similar in concept to the potential designs for the EIS alternatives. Recommendations from this section were based on results from these three sites.

BONNEVILLE SLUICEWAY

Bonneville Dam has three separate passage routes: Spillway, Powerhouse 1, and Powerhouse 2. Juvenile fish passage facilities at Powerhouse 1 consist of chain gates and an ice and trash sluiceway with a flow capacity near 2000 cfs. Powerhouse 1 was equipped with a juvenile bypass system consisting of turbine intake screens, vertical barrier screens, gatewell orifices, a bypass channel, and an outfall. However, the juvenile bypass system was removed in 2002 due to low survival through that route. Powerhouse 1 has relatively high turbine survival. During the juvenile fish passage season, powerhouse 1 is operated as a second priority to Powerhouse 2. Powerhouse 2 has a corner collector and juvenile fish bypass system. These have relatively high passage efficiency and survival. Historical sluiceway passage values (Johnson et. al. 2007, Krcma et al. 1982, Ploskey et. al. 2007, Ploskey et al. 2012, Ploskey et al. 2012a) are summarized in Table 1-3.

THE DALLES - SLUICEWAY

The Dalles Dam sluiceway is located along the entire length of the 22-turbine-unit powerhouse, which is oriented parallel to the river channel centerline. Surface flow passes through weir-type chain gates into a channel that has a hydraulic capacity of 5,000 cfs. Historical passage efficiency values (Krcma et al. 1982, Ploskey et. al. 2007, Ploskey et al. 2012, Ploskey et al. 2012a, and Swan et. al. 1997) are over 50% (Table 1 3).

ICE HARBOR SLUICEWAY

The Ice Harbor Dam sluiceway was evaluated in 1995 prior to installation of a juvenile bypass system in the sluiceway channel. Combinations of wide surface-overflow entrances (6.1 m wide, 1.8 m deep, and 2.3 ms⁻¹ entrance velocity) and deeper, slotted, entrances (up to 1.8 m wide, 12.2 m deep, and up to 1.2 ms⁻¹ entrance velocity) were studied. The wide, surface overflow entrances had the highest passage rates based on hydroacoustics and radiotelemetry, where a total of 57% of the radio-tagged Chinook salmon used sluice gate 2B, which was a surface-skimming flow (Swan et al. 1996).

Table 1-3. Historical fish passage efficiency Relative to Powerhouse passage at Bonneville, The Dalles, and Ice Harbor

Project	Spring Hydro-Acoustic	Summer Hydro-Acoustic	CH1 Active Tag	Steelhead Active Tag	CHO Active Tag
Bonneville	35% (33-37)	46% (29-71)	41% (24-77)	49% (29-65)	42% (13-77)
The Dalles	–	–	51% (25-67)	56% (46-63)	28% (18-51)
Ice Harbor	–	–	57%	–	–

The literature on surface passage efficiency for sluiceways at FCRPS projects shows a wide range of factors to regulate surface passage structure efficiency. They inform us of the potential efficiency of similar surface passage structures. For example, we assume values reported for Ice Harbor and The Dalles sluiceway are slightly inflated when compared to Bonneville because without powerhouse surface passage at these projects there would be greater opportunity for fish approaching the powerhouse to reject that route and pass via the spillway. This uncertainty still exists at Bonneville but, due to its configuration, the likelihood of rejecting the powerhouse is substantially reduced.

ASSUMPTIONS

The proposed powerhouse surface passage structures would incorporate higher design discharges than most of the structures reviewed, relative to powerhouse capacity. These structures would also be designed to maximize the potential for fish discovery with hydraulics that reduce or eliminate rejection. Therefore, an assumed 30% efficiency for powerhouse surface passage structures is likely too conservative when compared to available literature, and would lead to a low estimate for alternatives effects on fish species. In addition, the assumed efficiencies of these routes varies by species. ***Consequently, the team chose Powerhouse Surface Passage efficiencies for sub-yearling and yearling Chinook, and Steelhead at 30, 40, and 50% respectively for purposes of the CRSO EIS effects analysis.***

1.1.1.6 IFP Turbines

Improved Fish Passage (IFP) turbines are proposed or planned for installation at three projects: Ice Harbor, McNary, and John Day. In order to effectively model the impact of these new turbines, modelers need an estimate of the degree of improvement in the turbine environment and resulting fish survival. Because each dam and even each turbine has a different potential for survival, relative survival improvements need to be calculated for units receiving new turbines. A turbine performance evaluation was conducted by the USACE, Walla Walla District to estimate this relative improvement.

Turbine mortality is split into direct and indirect mortality. Direct turbine mortality includes injuries that occur during turbine passage, while indirect turbine mortality can include effects like predation that occur as a result of disorientation or poor egress following turbine passage. The primary sources of direct turbine mortality come from mechanical, shear or pressure related injuries.

Physical hydraulic models were used to evaluate the potential for mechanical and sheer related injuries, while potential for pressure related injuries was evaluated using sensor fish or computation fluid dynamic (CFD) models.

PHYSICAL MODELS

Based on ERDC physical modeling, mechanical and sheer related injuries would be reduced by **45 and 66 percent** for the new adjustable and fixed blade IFP turbines respectively (Table 1-4).

PRESSURE MODELS

For pressure related injuries the upper one percent operating condition was chosen for comparisons since this is generally associated with the highest calculated fish passage mortality from pressure related injuries.

The Ice Harbor existing, new fixed and new adjustable IFP turbines were analyzed using CFD models. These models were used to determine a calculated barotrauma mortality for the upper operating point for each of these turbines. The improvement over existing turbines, in reduced calculated barotrauma mortality, was estimated at **69 and 77 percent** for new adjustable and fixed blade IFP turbines respectively.

Assumptions:

- 1) A portion of the pressure mortality is already accounted for in the strike mortality. For the sake of this analysis an assumption of 50% of fish that would be exposed to mortal low pressures would also be exposed to strike or shear mortality.
- 2) Improvements seen in Ice Harbor testing/modeling would be similar for John Day and therefore the same percentage improvement in direct mortality will be seen.

To get a final estimate of improvements in direct turbine survival the team needs to combine the estimates of mortality from turbine physical models and estimates of barotrauma mortality from CFD models. Because many of the fish that pass close enough to blades to be struck will also potentially experience low pressures, the two estimates are not simply additive.

Indirect mortality following turbine passage within the tailrace is harder to assess. With reductions in injury through the turbine runner and improvements to the flow within the draft tube environment, it is anticipated that the modification at Ice Harbor will reduce indirect mortality as well as direct mortality. While direct mortality can be assessed numerically as noted above, it is difficult to separate out the indirect mortality that is occurring for the existing or new turbine units. Consequently, these estimates are for direct mortality only.

Table 1-4. Calculated Combined Fish Passage Mortality Improvement from Existing Ice Harbor Turbines to New Ice Harbor IFP Turbines

IFP Runner	Reduction in Strike Mortality (%)	Reduction in Barotrauma Mortality (%)	Combined Reduction in Mortality (%)
Fixed Blade	66%	77%	68.1%
Adjustable Blade	45%	69%	49.0%

Because it has not been determined how many units will be fixed or adjustable for future powerhouse replacement, a conservative value of 50 percent, closer to the lower of the two estimated improvements was selected (i.e. turbines with 80 percent survival would see improvements to 90 percent or a reduction in mortality of 50 percent). This approach would be assumed for Ice Harbor and McNary in the No Action Alternative, and for John Day in all other alternatives.

1.2 MODELS

1.2.1 COMPASS Model

The COMPASS model produces juvenile survival metrics for Upper Columbia and Snake River ESUs of spring Chinook salmon and steelhead. The COMPASS model was developed to predict the effects of alternative operations of Snake and Columbia River dams on juvenile salmon survival, travel time, and ocean arrival time. Survival is estimated in two steps - direct effects of the hydrosystem and latent effects which occur outside the hydrosystem. Although the COMPASS model can be used for a variety purposes, including in-season monitoring of survival and travel time, the primary function of the model is to compare hydrosystem survival across management scenarios. The three main operations that vary among management scenarios are flow, proportion of river flow passed through the spillway, and transportation. For additional information regarding the COMPASS model see Zabel et al. 2008 and the COMPASS model documentation from 2019.

The Comprehensive Passage (COMPASS) model was developed by scientists from throughout the Pacific Northwest for use by regional biologists to predict the effects of alternative operations of Snake and Columbia River dams on salmon and steelhead survival rates (Zabel et al. 2008). COMPASS results were generated for all alternatives using COMPASS version 2-8-7b with June 2018 survival and traveltime calibrations for either Snake River or upper Columbia River ESUs of spring Chinook salmon and steelhead. Population indices at Lower Granite Dam were estimated for each year in the 80-year water record with temperature and flow data for the NAA scenario; these yearly indices were used as the initial release distributions in the COMPASS model.

1.2.1.1 COMPASS Changes

There were several ways in which scenario runs for the CRSO EIS alternatives differed from the “default” configuration of the COMPASS model. These include the way SARs were generated, use and documentation of Upper Columbia spring Chinook modules, water temperature inputs,

the inclusion of additional powerhouse surface passage routes and Improved Fish Passage turbines, alterations for breaching scenarios, and assumptions regarding hatchery stocks.

1.2.1.2 Smolt to Adult Returns

The COMPASS model documentation makes references in several places to estimation of post-Bonneville survival. These features are essentially smolt-to-adult return rate (SAR) models. These SAR models are still present and functional in COMPASS, so the team has left references to these models in the documentation. However, it is important to note that, for the CRSO COMPASS runs, only the within-hydrosystem portion of the COMPASS model was used. The SAR models used for CRSO scenario analysis are not part of the COMPASS model and are not documented within the COMPASS documentation; instead, please refer to documentation of the life cycle model for all post-Bonneville portions of our CRSO scenario runs.

1.2.1.3 Upper Columbia Analyses

Because there is no current documentation and diagnostics for the calibrated COMPASS models for upper Columbia River (UC) stocks of spring Chinook and steelhead similar to what is presented for Snake River stocks in Appendices 1 and 2 of the COMPASS documentation, COMPASS calibration for these species are discussed here. PIT tag data of upper Columbia River origin fish were used to generate CJS estimates of survival to calibrate to, in a process essentially identical to that done for Snake River stocks. Only spring-run UC Chinook salmon data was used; any summer-run UC Chinook were excluded from the calibration data. All UC origin steelhead detected at Rock Island Dam or McNary Dam were used.

Models were calibrated to two reaches; Rock Island Dam to McNary Dam and McNary Dam to Bonneville Dam. Similar to the process for Snake River stocks, the McNary to Bonneville reach was calibrated first, and then that calibrated model was used for McNary Pool in the process of calibrating the Rock Island Dam to McNary Dam reach. There is one major difference compared to how Snake River stocks were calibrated: in the McNary to Bonneville reach, data from UC-origin fish alone was insufficient to produce satisfactory reservoir survival model fits. Data from UC origin fish was added to Snake River origin fish to calibrate survival in the McNary to Bonneville reach. The migration rate model calibration for that reach still used UC-origin data exclusively.

The resulting best-fit models for UC stocks of Chinook and steelhead were comparable to models for Snake River stocks in the McNary to Bonneville reach and simpler than Snake River models in the Rock Island to McNary reach. The reservoir survival models for both species of UC stocks have travel time and temperature as predictors for the McNary to Bonneville reach and travel time alone as a predictor for the Rock Island to McNary reach. The migration rate models for both species of UC stocks have flow and spill as major predictors in both calibration reaches, and tend to be less sensitive to temperature than Snake River stocks but more sensitive to spill.

1.2.1.4 Water Temperature

The COMPASS model documentation makes reference in a few places to water temperature models that use flow relationships to predict water temperature within the hydrosystem. This water temperature model was not used for CRSO scenario runs; instead, the team used water temperature predicted by the ACOE and transmitted to the COMPASS team as part of the overall H&H dataset.

1.2.1.5 Powerhouse Surface Passage

In COMPASS, each passage route has a passage efficiency assigned to it. Powerhouse surface passage efficiency is defined as the portion of powerhouse fish that pass via the surface passage route. For alternatives that included powerhouse surface passage structures the team assumed different surface passage efficiencies of 0.4 for yearling Chinook and 0.5 for steelhead. Existing sluiceways at The Dalles and Bonneville have surface passage efficiencies that were derived from previous studies. See discussion in Methods section of this appendix for more detail.

1.2.1.6 IFP Turbines

For modeling purposes the team assumed the installation of IFP turbines at Ice Harbor, McNary and John Day dams would reduce turbine induced injury and mortality by 50% (Table 1-5). See discussion in Methods section of this appendix for more detail.

Table 1-5. Estimated turbine mortality for juvenile Chinook in Ice Harbor, McNary, and John Day Reservoirs

Project/Species Combination	Before IFP Turbine installation	After IFP Turbine installation
ICE Chinook	0.0570	0.0285
ICE Steelhead	0.1290	0.0645
MCN Chinook	0.1283	0.0642
MCN Steelhead	0.2110	0.1055
JDA Chinook	0.1125	0.0563
JDA Steelhead	0.1833	0.0916

1.2.1.7 MO3 Alterations

The COMPASS model was substantially reconfigured for CRSO alternative MO3 – the dam breaching alternative. Model parameters and diagnostics are included in the documentation for models upstream of Lower Granite Dam. There are two sets of such models: one model from the Snake River Trap to Lower Granite Dam, and a second model from the Imnaha River and Grande Ronde River traps to Lower Granite Dam. Since all model statistics for the CRSO scenario runs are from Lower Granite Dam to Bonneville Dam, these models from above Lower Granite Dam are not used in normal scenario runs. The exception is alternative MO3.

In the MO3 alternative, all four dams on the Snake River are breached. For this alternative, a modified version of COMPASS was created. This version of COMPASS removes all Snake River dam-related models and allows all former pools within the Snake River to flow freely, without impoundment. Fish were released from the same location in MO3 runs as in other alternatives (just above the site of Lower Granite Dam). However, instead of the normal models, survival and travel time models that were fit to the segment of the Snake River between the Imnaha River trap and the Snake River trap were used. Survival and travel time models fitted to data from the free-flowing portion of the middle Snake River above Lower Granite Pool will be used for the breached lower Snake River in alternative MO3. Three different COMPASS runs, using three different model calibrations were used to evaluate dam breaching (MO3). These runs were evaluated for wild and hatchery fish combined and for wild fish only in the event that the Snake River Compensation hatcheries would be closed after breaching. The same release distributions were used, but were adjusted earlier or later based on the predicted difference in mean travel time in Lower Granite Pool under the NAA alternative versus under each MO3 calibration.

MO3-SNK uses COMPASS calibrated to the historical migration and reservoir survival between Lower Granite and McNary. Under this calibration the model uses the same reservoir migration and survival model used for the other alternatives. This model is fitted based on PIT tag data between Lower Granite and McNary dams from 1998-2017. Therefore, all fish used for this model's calibration were experiencing an impounded river. The dam breach in alternative MO3 will change the river environment to conditions well outside the range of the calibration dataset with water velocities 5-8 times faster under MO3 than in the calibration data. The model responds to this change in water velocity and there are no numerical issues with using the model in MO3. However, it is unknown if the behavioral patterns fitted by the model will hold or if they will change at higher velocities.

MO3-SAL uses COMPASS calibrated to historical migration and survival patterns above the Snake River smolt trap for fish tagged at the Salmon River Trap and assumes that this population represents the whole. The model used for the MO3-SAL run is fitted to PIT tag data from fish tagged at the Salmon River smolt trap near Whitebird, ID. Thus, only fish from populations in the Salmon River basin are included in the calibration for this model. Since the results are being compared here to other alternatives run with a calibration fitted to data from all Snake River salmon populations, there is a possibility that inherent differences between Salmon River origin fish and other Snake River fish may influence the relative results. Raw data used for calibration shows that daily survival and migration rates appeared very similar to those from basin-wide datasets originating at the Snake River smolt trap and Lower Granite and appears to validate the assumption.

While the timing and location are different between the calibration and prospective reaches under MO3-SAL the team assumes behavior remains the same. The model used for the MO3-SAL run is fitted to PIT tag data in the reach from the Salmon River smolt trap near Whitebird, ID to the Snake River smolt trap at Lewiston, ID. This reach is upstream of the reach where the model was applied prospectively in MO3. There is a possibility that physiological or behavioral

differences would occur in actuality that the model does not capture. However, the fitted model form and migration and survival model slopes fitted to the Salmon Trap data are very similar to those seen in the impounded lower Snake River, this assumption is probably not having a large effect.

The final run for breaching, MO3-GRNIMN, uses a COMPASS calibration fitted to PIT tag data from fish tagged at the lower Grande Ronde River and Imnaha River smolt traps. Therefore, only fish from populations in eastern Oregon are included in the calibration for this model. Since the results are being compared here to other alternatives run with a calibration fitted to data from all Snake River salmon populations, there is a possibility that inherent differences between eastern Oregon fish and other Snake River fish may influence the relative results. Raw data used for calibration were examined and showed that daily survival rates were lower on average than those from basin-wide datasets and Salmon River fish. Additionally, the Grande Ronde and Imnaha survival rates displayed a steeper drop in survival later in the migration season than in data from other populations. This pattern in the data influenced the slopes fitted in survival model calibration. Consequently, the MO3-GRNIMN model likely estimates lower survival than models calibrated to all Snake River populations.

While the timing and location are different between calibration and prospective reaches, the team assumed that behavior remains the same. Prior to late April, Grande Ronde and Imnaha trap fish display very slow migration rates with no detectable relationship between migration rate and water velocity. Fish from the Salmon River or from basin-wide samples at Lower Granite Dam and the Snake River trap do not display this pattern in migration rate. It is possible that many of the fish tagged in April at the Grande Ronde and Imnaha traps are not yet smolted and are still rearing, which would explain their slow migration rates. It is questionable whether these fish will continue to migrate slowly through the rest of the Snake River. If these fish become more smolted as they move downstream, the model may underpredict their migration rates in lower reaches of the Snake River.

It appears that both assumptions for the MO3-GRNIMN calibration are being violated to some extent. However, after detailed examination of the calibration process, no errors were found in calibration. While it seems unlikely that the Grande Ronde and Imnaha dataset is representative of the Snake River as a whole, it is an important component of the basin-wide population, and it is valuable to include this calibration for comparison to the other models and as a measure of the uncertainty associated with the MO3 alternative.

1.2.1.8 Hatchery Production

It was assumed hatcheries that compensate for the Snake River projects would be closed after the dams were removed. As a result, wild fish would dominate the anadromous smolt populations. To evaluate the effects to modeling an additional model run was conducted for MO3-SAL using only wild fish. MO3-SAL was selected because the calibration is already dominated by approximately 75% wild fish and the initial runs showed values in the mid-range of the other two model calibrations. This run uses dam routing equations fitted to only wild fish and used the same reservoir survival and traveltime models, which are fitted to a dataset

containing approximately 75% wild fish and 25% hatchery fish; thus, reservoir survival and traveltime predominately reflects wild fish in both the hatchery-wild and wild only runs, though there is some hatchery influence.

1.2.1.9 Measures not Modeled

Modification of the Juvenile Bypass Facility at Lower Granite Dam and gateway modifications at Bonneville powerhouse number 2 were not modeled due to model limitations.

1.2.1.10 Statistics and Data Fields

These analyses generated summary statistics and raw data for Snake River spring summer Chinook and steelhead and upper Columbia River spring Chinook and steelhead for each alternative. While descriptions of summary statistics and raw data fields are presented here, all data and results are discussed in the section for data – Data and Results. Descriptions of summary statistics are shown in Tables 1-6 and 1-7, with descriptions of raw data fields in Tables 1-8 and 1-9, and descriptions of dam passage fields are shown in Table 1-10.

Table 1-6. Description of summary statistics reported from the COMPASS model for Snake River spring-summer Chinook and steelhead for each alternative

Statistic	Description
Mean Survival	80-year average in-river survival (LGR Forebay to BON Tailrace)
95% CI Survival	95% confidence interval of mean in-river survival
Mean Arrival at BON	Mean Julian day of fish arriving at Bonneville Dam (in-river migrants only)
Proportion Destined for Transport	Proportion of fish that would have been transported if in-river survival were 100%
Mean Gas Exposure	Average dissolved gas level experienced by fish across LGR Pool to Bonneville Pool
Proportion Powerhouse Passage	The proportion of all dam passage events (from LGR to BON) that were via the turbines or bypass routes (sluiceways are treated as a spill route)
Mean Traveltime (LGR-MCN)	80-year average travel time in days from LGR Forebay to MCN Tailrace
Mean Traveltime (MCN-BON)	80-year average travel time in days from MCN Tailrace to BON Tailrace
Mean Migration Rate (LGR-MCN)	80-year average migration rate in miles per day from LGR Forebay to MCN Tailrace
Mean Migration Rate (MCN-BON)	80-year average migration rate in miles per day from MCN Tailrace to BON Tailrace
Mean Temp Experience (Snake)	Average temperature experienced by in-river migrant fish across LGR Pool to IHA Tailrace
Mean Temp Experience (Columbia)	Average temperature experienced by in-river migrant fish across MCN Pool to BON Pool
Mean Flow Experience (Snake)	Average flow experienced by in-river migrant fish across LGR Pool to IHA Tailrace
Mean Flow Experience (Columbia)	Average flow experienced by in-river migrant fish across MCN Pool to BON Pool

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Statistic	Description
Mean Gas Experience (Snake)	Average dissolved gas experienced by in-river migrant fish across LGR Pool to IHA Tailrace
Mean Gas Experience (Columbia)	Average dissolved gas experienced by in-river migrant fish across MCN Pool to BON Pool
Avg. Num Bypasses	Average passage history of dam passages through a bypass system across the 8 FCRPS Dams (includes partial passage information of inriver morts and transported fish)
Avg. Num Turbine Passages	Average passage history of dam passages via turbines across the 8 FCRPS Dams (includes partial passage information of inriver morts and transported fish)
Avg. Num Spill Passages	"Spill Passages" Average passage history of dam passages through a spillway or sluiceway across the 8 FCRPS Dams (includes partial passage information of inriver morts and transported fish)

Table 1-7. Description of summary statistics reported from the COMPASS model for Snake River spring-summer Chinook and steelhead for each alternative

Statistic	Description
Mean Survival	80-year average in-river survival (Rock Island Pool to BON Tailrace)
Mean Survival (MCN to BON)	80-year average in-river survival (McNary Pool to BON Tailrace)
SD survival (year-to-year)	Standard deviation in in-river survival among the 80 water years
Mean Arrival at BON	Mean Julian day of fish arriving at Bonneville Dam (in-river migrants only)
Proportion Destined for Transport	Proportion of fish that would have been transported if in-river survival were 100%
Mean Gas Exposure	Average dissolved gas level experienced by fish across Rock Island Pool to Bonneville Pool
Proportion Powerhouse Passage	The proportion of all dam passage events (from RIS to BON) that were via the turbines or bypass routes (sluiceways are treated as a spill route)
Mean Travel time (WEL-MCN) (Days)	80-year average travel time in days from Rock Island Pool to the head of McNary Pool
Mean Traveltime (MCN-BON) (Days)	80-year average travel time in days from MCN Tailrace to BON Tailrace
Mean Migration Rate (WEL-MCN) (mi/day)	80-year average migration rate in miles per day from Rock Island Pool to the head of McNary Pool
Mean Migration Rate (MCN-BON) (mi/day)	80-year average migration rate in miles per day from MCN Tailrace to BON Tailrace
Mean Temp Experience (WEL-Hanford)	Average temperature experienced by in-river migrant fish across Rock Island Pool to the Hanford Reach
Mean Temp Experience (Lower Columbia)	Average temperature experienced by in-river migrant fish across MCN Pool to BON Pool
Mean Flow Experience (WEL-Hanford)	Average flow experienced by in-river migrant fish across Rock Island Pool to the Hanford Reach
Mean Flow Experience (Lower Columbia)	Average flow experienced by in-river migrant fish across MCN Pool to BON Pool
Mean Gas Experience (WEL-Hanford)	Average dissolved gas experienced by in-river migrant fish across Rock Island Pool to the Hanford Reach
Mean Gas Experience (Lower Columbia)	Average dissolved gas experienced by in-river migrant fish across MCN Pool to BON Pool

Statistic	Description
Avg. Num Bypasses	Average passage history of dam passages through a bypass system across 3 Mid-Columbia dams (RIS, WAN, and PRD) and 4 Lower Columbia dams (includes partial passage information of inriver morts)
Avg. Num Turbine Passages	Average passage history of dam passages via turbines across 3 Mid-Columbia dams (RIS, WAN, and PRD) and 4 Lower Columbia dams (includes partial passage information of inriver morts)
Avg. Num Spill Passages	Average passage history of dam passages through spillways and sluiceways across 3 Mid-Columbia dams (RIS, WAN, and PRD) and 4 Lower Columbia dams (includes partial passage information of inriver morts)

Table 1-8. Description of raw data fields reported from the COMPASS model for Snake River spring-summer Chinook and steelhead for each alternative

Field	Description
Year	Year of the 80-year water record
Species	Species used for run
InRivSurvSNK	In-River Survival from Lower Granite Tailrace to the confluence with the Columbia River
InRivSurvLCol	In-River Survival from McNary Pool to Bonneville Dam
InRivSurv	In-River Survival from Lower Granite Dam to Bonneville Dam
ProportionTransported	Proportion of fish destined to be transported if reservoir survival were 100%
MedDayLGR	Median julian day of fish passage at LGR (in-river migrants only)
MedDayConfl	Median day of fish passage at confluence of Snake and Columbia
MedDayBONinriv	Median day of fish passage at Bonneville tailrace (in-river migrants only)
MedDayBONtrans	Median day of fish passage at Bonneville tailrace (transported fish only)
meanTravelTime	Mean fish travel time (days) from Lower Granite Dam to Bonneville Dam
meanMigRate	mean fish migration rate (mi/day)
meanTemp	Mean fish temperature experience- weighted average of temperature by fish passage
meanFlow	Mean fish flow experience- weighted average of flow by fish passage
meanFSpill	Mean fish spill experience- weighted average of spill by fish passage
meanGas	Mean fish gas experience- weighted average of gas by fish passage
SNKTravelTime	Mean fish travel time (days) from Lower Granite Dam to the confluence with the Columbia
SNKMigRate	Mean fish migration rate (mi/day) in the Snake
SNKTemp	Mean fish temperature experience in the Snake
SNKFlow	Mean fish flow experience in the Snake
SNKFSpill	Mean fish spill experience in the Snake
SNKGas	Mean fish gas experience in the Snake
LCTravelTime	Mean fish travel time (days) from McNary Pool to Bonneville Dam
LCMigRate	Mean fish migration rate (mi/day) in the Columbia
LCTemp	Mean fish temperature experience in the Columbia
LCFlow	Mean fish flow experience in the Columbia
LCFSpill	Mean fish spill experience in the Columbia
LCGas	Mean fish gas experience in the Columbia

Field	Description
BonFlow	Mean spring flow in Bonneville Pool
propBONinriv	Proportion of fish surviving to Bonneville which were in-river migrants
propBONtrans	Proportion of fish surviving to Bonneville which were transported
InRivSurv_q975	Upper 97.5% quantile of In-River Survival from Monte Carlo scenario analysis
InRivSurv_q025	Lower 2.5% quantile of In-River Survival from Monte Carlo scenario analysis

Table 1-9. Description of raw data fields reported from the COMPASS model for Upper Columbia River spring Chinook and steelhead for each alternative

Field	Description
Year	Year of the 80-year water record
Species	Species used for run
InRivSurvUC	In-River Survival from Rock Island Pool to the head of McNary Pool
InRivSurvLCol	In-River Survival from McNary Pool to Bonneville Dam
InRivSurv	In-River Survival from Rock Island Pool to Bonneville Dam
MedDayRIS	Median julian day of fish passage at Rock Island Dam
MedDayConfl	Median day of fish passage at confluence of Snake and Columbia
MedDayBON	Median day of fish passage at Bonneville tailrace
meanTravelTime	Mean fish travel time (days) from Rock Island Pool to Bonneville Dam
meanMigRate	mean fish migration rate (mi/day)
meanTemp	Mean fish temperature experience- weighted average of temperature by fish passage
meanFlow	Mean fish flow experience- weighted average of flow by fish passage
meanFSpill	Mean fish spill experience- weighted average of spill by fish passage
meanGas	Mean fish gas experience- weighted average of gas by fish passage
UCTravelTime	Mean fish travel time (days) from Rock Island Pool to the head of McNary Pool
UCMigRate	Mean fish migration rate (mi/day) from Rock Island Pool to the head of McNary Pool
UCTemp	Mean fish temperature experience from Rock Island Pool to the head of McNary Pool
UCFlow	Mean fish flow experience from Rock Island Pool to the head of McNary Pool
UCFSpill	Mean fish spill experience from Rock Island Pool to the head of McNary Pool
UCGas	Mean fish gas experience from Rock Island Pool to the head of McNary Pool
LCTravelTime	Mean fish travel time (days) from McNary Pool to Bonneville Dam
LCMigRate	Mean fish migration rate (mi/day) from McNary Pool to Bonneville Dam
LCTemp	Mean fish temperature experience from McNary Pool to Bonneville Dam
LCFlow	Mean fish flow experience from McNary Pool to Bonneville Dam
LCFSpill	Mean fish spill experience from McNary Pool to Bonneville Dam
LCGas	Mean fish gas experience from McNary Pool to Bonneville Dam
BonFlow	Mean spring flow in Bonneville Pool

Table 1-10. Description of passage data fields reported from the COMPASS model for Snake and Upper Columbia River spring Chinook and steelhead for each alternative

Field	Description
Year	Year in the 80-year set
Species	Species used for the run
PropSpill_XXX	Proportion of fish that passed via normal spillbay at dam XXX
PropRSW_XXX	Proportion of fish that passed via RSW spillbay at dam XXX
PropSluice_XXX	Proportion of fish that passed via sluiceway at dam XXX (at Bonneville the corner collector is a sluiceway route)
PropBypass_XXX	Proportion of fish that passed via bypass at dam XXX
PropTurbin_XXX	Proportion of fish that passed via turbines at dam XXX
ProbXBypass	Given a fish survived to Bonneville tailrace, the probability it would have been bypassed X times
PropXTurbine	Given a fish survived to Bonneville tailrace, the probability it would have passed via turbines X times
PropXSpillway	Given a fish survived to Bonneville tailrace, the probability it would have passed via spill (normal spillbay or RSW) X times

1.3 NWFSC LIFE CYCLE MODEL

Northwest Fisheries Science Center (NWFSC) Life Cycle Modeling (LCM) uses COMPASS hydrosystem passage inputs to produce estimates of adult return metrics for one population (Wenatchee) of Upper Columbia Spring Chinook salmon, and for three population groups (South Fork Salmon, East Fork Salmon, and Upper Salmon) of Snake River Spring Chinook salmon (Table 1-11).

Table 1-11. Chinook populations used in the NOAA LCM analysis are listed below by basin

Chinook Population Group	Basins	Fish Populations
Snake River spring-summer Chinook	Middle Fork Salmon River	Bear Valley Creek
Snake River spring-summer Chinook	Middle Fork Salmon River	Big Creek
Snake River spring-summer Chinook	Middle Fork Salmon River	Camas Creek
Snake River spring-summer Chinook	Middle Fork Salmon River	Loon Creek
Snake River spring-summer Chinook	Middle Fork Salmon River	Marsh Creek
Snake River spring-summer Chinook	Middle Fork Salmon River	Sulphur Creek
Snake River spring-summer Chinook	South Fork Salmon River	Secesh River
Snake River spring-summer Chinook	South Fork Salmon River	South Fork Salmon River
Snake River spring-summer Chinook	South Fork Salmon River	East Fork South Fork
Snake River spring-summer Chinook	Upper Salmon River	Salmon R. Upper Main
Snake River spring-summer Chinook	Upper Salmon River	Yankee Fork
Snake River spring-summer Chinook	Upper Salmon River	East Fork
Snake River spring-summer Chinook	Upper Salmon River	Pahsimeroi
Snake River spring-summer Chinook	Upper Salmon River	Salmon R. Lower Main
Snake River spring-summer Chinook	Upper Salmon River	Lemhi (above Redfish)
Snake River spring-summer Chinook	Upper Salmon River	N. Fork Salmon

Chinook Population Group	Basins	Fish Populations
Snake River spring-summer Chinook	Upper Salmon River	Catherine Creek
Snake River spring-summer Chinook	Upper Salmon River	Valley Creek
Upper Columbia River Spring Chinook	Wenatchee	Wenatchee

The set of NWFSC life cycle models developed in support of the 2018 FCRPS Biological Opinion range in complexity as far as the number of distinct life stages, and dynamic relationships with river and ocean environment, habitat factors, predators, and climate variability and change (NOAA Technical memo, Zabel and Jordan (Eds.); in press). The models used to estimate SAR and adult abundance for the 2019 CRSO-EIS used a Multivariate Autoregressive State Space (MARSS) modeling framework (Crozier and Zabel in press, Jorgensen in press). The MARSS method to fit survival relationships with environmental factors, and accurately simulate natural variability is described in Burke et al. (in press), and Holmes et al. 2012. The five life stages defined by the model included fall spawning and early rearing, later tributary rearing including downstream migration through the Snake and Columbia river, early ocean entry, additional years in the ocean, and pre-spawn survival as adults. Early life stages are modeled in the COMPASS model, while later life stages are modeled here. Jack returns are included in SAR estimates (Figure 1-1).

Data inputs used to develop this model for Upper Columbia, and three Salmon River major population groups include run reconstruction based estimates of wild spawner abundance, age structure, hatchery fraction and harvest rate, as well as stage specific survival estimates from juveniles PIT tagged as parr. Survival from the smolt to adult stage for both groups was estimated from pit-tag detections at Bonneville Dam. Upstream survival is also based on pit-tag detections from Bonneville Dam to Lower Granite Dam 2004-2016, and includes harvest in the mainstem rivers (Crozier et al. 2016). Survival from Lower Granite Dam to the spawning grounds (i.e., pre-spawn mortality) was treated as a constant (0.9), based on data summarized by Bowerman et al. (2016).

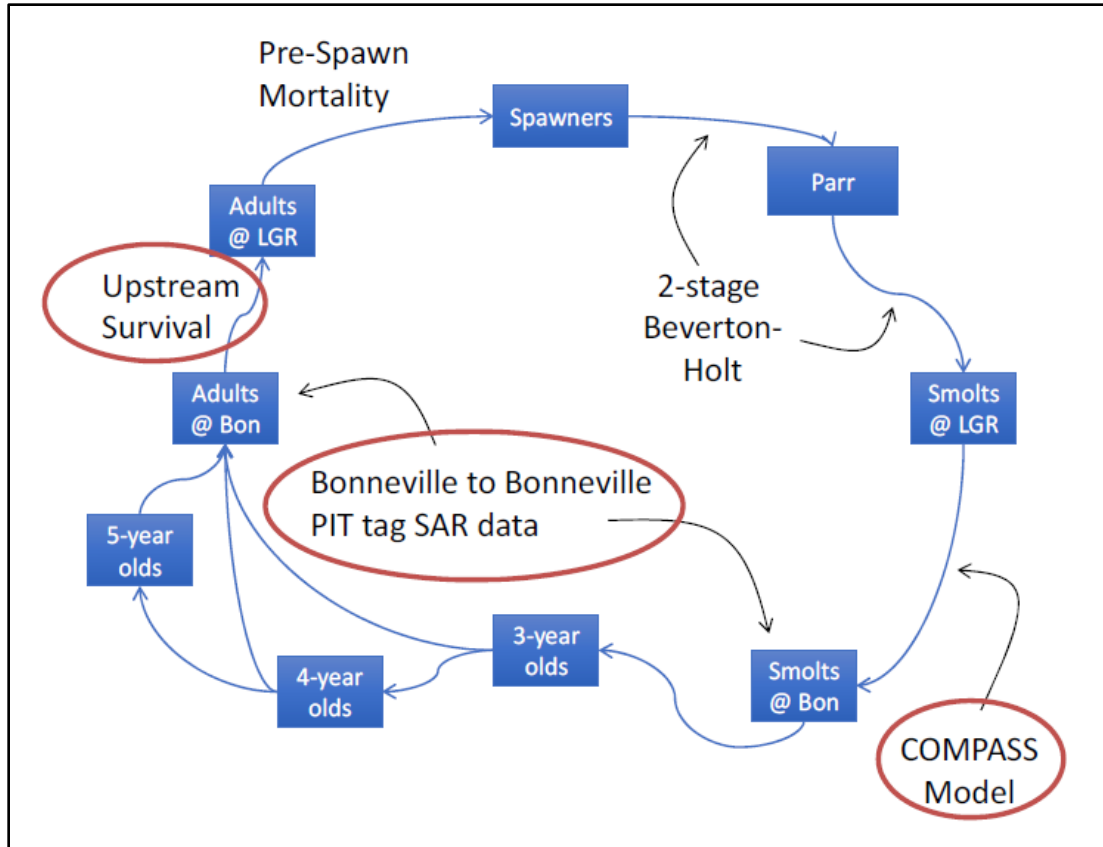


Figure 1-1. Flow for NOAA life cycle modeling

1.3.1 Smolt to adult return

The approach used to estimate survival from arrival at Lower Granite Dam to adult return at Bonneville and Lower Granite Dams is described in Burke et al. (in press). Survival and travel time output from the COMPASS model representing alternative scenarios of hydrosystem management was integrated into the model of wild adult abundance (Faulkner et al. in press). Data from both hatchery and wild origin juveniles was used to calibrate functional relationships with dam operations and river conditions in COMPASS. COMPASS implementation notes in this technical appendix describe the steps taken to address structural and operational measures included under each CRSO alternative.

Post-Bonneville survival through the lower Columbia estuary and 1-3 years of ocean survival are simulated with ocean indicators determined to have strong correlation with SAR. These include the winter sea surface temperature, the summer sea surface temperature along the Washington and Oregon coast, and the coastal upwelling index. The MARSS approach was used to simulate ocean conditions while capturing realistic correlation structure among covariates.

Ocean entry timing has previously been found to have a significant effect on SAR (Scheuerell et al. 2009). On average, a delay in the date of ocean entry could result reduced survival, particularly later in the season. PIT-based SAR data from smolts detected at Bonneville Dam has shown a different annual level of effect of the date of ocean entry, so yearly effects were

simulated in the model with a combination of a linear random effects term and a quadratic fixed effects term that allowed date of entry to have a different level of effect, comparable to the observed data. Transported fish were assumed to have high survival in the barges (0.98), but tend to have lower post-Bonneville return rates compared to in-river migrants, particularly early in the season. The transport to in-river ratio (TIR) has a strong seasonal component, and SAR rates of transported fish were modeled separately from in-river fish.

NOAA Life Cycle Modeling did not contain estimates of latent mortality. Rather, sensitivity analyses were conducted by estimating reductions in latent mortality of 0, 10, 25, 50 and 100 percent. Estimates of fish population numbers generated from these latent mortality analyses were reviewed by the modeling team. Values modeled under 100 percent latent mortality often generated fish population numbers 10 to 20 times greater than the NAA. These values were deemed unreasonable and estimates for 100 percent latent mortality were not included in further analyses or discussions. A potential latent mortality benefit was not considered in MO2 because this alternative was not expected to mitigate latent mortality.

1.4 CSS MODELS

The Comparative Survival Study began in 1996 and resides within the Northwest Power and Conservation Council's Columbia Basin Fish and Wildlife Program (NPCC FWP). Regional scientists currently manage the models and data that feed the CSS with the objective of establishing and monitoring long-term data sets of juvenile survival and adult returns for Salmon and Steelhead in the Columbia Basin. (CSS 2018). Comparative Survival Study (CSS) models were used to produce both juvenile and adult metrics for the Snake River Spring/Summer Chinook and steelhead ESUs. A suite of models were utilized to analyze the CRSO operations alternatives. The CSS 'cohort' models were applied to analyze expected juvenile survival, juvenile Fish Travel Time (FTT), ocean survival, SARs, and Transport:In-river Ratios (TIRs) for yearling Chinook salmon and steelhead from the Snake River Basin. The CSS Life Cycle Model was also applied to analyze expected Smolt-to-Adult Return rates (SARs) and adult spawning ground abundances for six tributary populations of Chinook salmon in the Grand Ronde Basin (McCann 2017, chapter 2 <http://www.fpc.org/documents/CSS/2017%20CSS%20Annual%20Report%20ver1-1.pdf>). The 80-year water record and predicted flow and spill data sets for each CRSO alternative, provided by BPA, were utilized in these analyses.

1.4.1 CSS Cohort model

Full documentation of the CSS cohort model, used to generate juvenile fish travel time, juvenile fish survival, and TIR relative to CRSO Alternatives, is provided in the CSS memo ("Documentation of Experimental Spill Management: Models, Hypotheses, Study Design, and response to ISAB" <http://www.fpc.org/documents/memos/30-17.pdf>). Chapter 3 describes retrospective analysis of observed PIT tag data for development of the model. The objective of these efforts was to identify the best fitting, most parsimonious, and biologically supportable models to describe the relationships between demographic response metrics and sets of

independent variables. Chapter 6 of the documentation shows an example of prospective modeling using simulated hydrosystem inputs under non-CRSO spill scenarios.

For the Cohort models, the input variables include water transit time, proportion of river spilled (PITPH), date of juvenile release at Lower Granite Dam, and ocean conditions. CSS cohort model predictions of juvenile fish travel time and juvenile survival have been validated by comparing to actual estimates from monitoring data. Operations data at each project across the 80-year water record were used as inputs for the models. For each cohort and water year, 10,000 random simulations were generated using the parameters described in the models presented. CSS model analyses have identified water transit time and spill, and the presence of removable spillway weir and temporary spillway weirs for steelhead, as the most important variables affecting smolt to adult return rates for Snake River salmon and steelhead.

1.4.2 CSS Life Cycle Model

The Life Cycle model applied to the Grande Ronde/Imnaha major population group of Snake River Spring Chinook is able to integrate decades of data on tributary adult spawners, tributary smolts, in-river survival estimates, ocean survival estimates, smolt-to-adult return estimates, and harvest estimates within a single framework. The predicted abundances and smolt-to-adult return rates (SARs) capture temporal trends in variability, as well as sensitivity to environmental drivers. Details on how SARs were estimated in the Life Cycle Model are provided in McCann et al. (2017, pg 30-33).

- The SARs presented in results include jacks.
- Harvest is treated as a random draw from historical harvests.
- Ocean indices are simulated.
- Transported fish were not included in the cohort-specific SARs.
- Comparisons of the SARs of transported smolts relative to the SARs of wild origin in-river smolts (i.e., the TIR ratio) are presented as a separate metric from the CSS cohort model.
- Summary statistics for SARs and return abundances were calculated slightly differently from the methods in McCann et al. (2017). In this analysis, the two metrics were averages over a random 10 year period in the 80 year simulations for each simulated outcome. This is in contrast to always taking the average of the last 10 years in McCann et al. (2017). All metrics are averages of 1000 simulations.

1.4.2.1 CRSO Implementation Notes

The CSS analyses of CRSO alternatives included three levels of assumed passage efficiencies for proposed Powerhouse Surface Passage (PSP) structures, measures included in several of the CRSO alternatives (10%, 20% and 30%).

Improved Fish Passage turbines are included as a measure in several of the CRSO alternatives. But CSS did not model the effects of these turbines.

The CSS modeling did not include any transportation from McNary Dam for MO2. MO2 includes a measure that specifies that no powerhouse screens will be installed at McNary Dam, however at the same time McNary Dam is included as an additional fish transportation site. Without screen installation, the proportion of juvenile fish available for transportation at McNary will be reduced. Fish that would have been routed to the collection system will pass through the powerhouse turbines.

1.4.2.2 PITPH documentation

PITPH is a metric that describes the expected number of powerhouse encounters during the downstream migration. For smolts originating upstream of Lower Granite Dam, if there is zero spill through the FCRPS, the PITPH would be 8. If there is 100% spill and no powerhouse operation PITPH would be 0.

In the dam breach scenario, in which the four lower Snake River Dams are removed, the maximum PITPH that could be experienced by downstream migrants will range from 0 to 4. Water transit time, which measures the average time for water to pass through each reservoir, would also be reduced in the Snake River under a dam breach scenario. <http://www.fpc.org/documents/CSS/2015%20CSS%20Annual%20Report.pdf> pg. 465-485. Tables 1-12 and 1-13 show the mean PITPH for Snake River spring-summer Chinook and Steelhead with different assumed Powerhouse Surface Passage (PHSP) collection efficiencies.

Table 1-12. Mean Seasonal average PITPH (95% confidence interval) for spring-summer Chinook over the 80-year water record for each alternative

Alternative	No PHSP	PHSP – 10% Efficiency	PHSP – 20% Efficiency	PHSP – 30% Efficiency
NAA	2.15 (2.06-2.23)	N/A	N/A	N/A
MO1	1.85 (1.72-1.97)	1.81 (1.69-1.94)	1.78 (1.65-1.90)	1.74 (1.62-1.87)
MO2	3.90 (3.82-3.98)	3.76 (3.68-3.84)	3.62 (3.54-3.70)	3.48 (3.41-3.56)
MO3	0.62 (0.57-0.67)	0.60 (0.55-0.65)	0.58 (0.53-0.63)	0.56 (0.51-0.61)
MO4	0.45 (0.40-0.50)	0.41 (0.37-0.46)	0.38 (0.33-0.42)	0.34 (0.30-0.38)

Note: PHSP refers to the addition of Powerhouse Surface Passage structures with assumed 10, 20, and 30% collection efficiencies.

Table 1-13. Mean Seasonal average PITPH (95% confidence interval) for spring-summer steelhead over the 80-year water record for each alternative

Alternative	No PHSP	PHSP – 10% Efficiency	PHSP – 20% Efficiency	PHSP – 30% Efficiency
NAA	1.96 (1.85-2.06)	NA	NA	NA
MO1	1.69 (1.56-1.83)	1.68 (1.54-1.81)	1.66 (1.53-1.79)	1.64 (1.51-1.77)
MO2	3.65 (3.55-3.75)	3.52 (3.43-3.62)	3.39 (3.30-3.48)	3.26 (3.18-3.35)
MO3	0.47 (0.42-0.52)	0.47 (0.42-0.52)	0.46 (0.41-0.51)	0.46 (0.41-0.51)
MO4	0.36 (0.31-0.42)	0.34 (0.29-0.39)	0.31 (0.26-0.36)	0.28 (0.24-0.32)

Note: PHSP refers to the addition of Powerhouse Surface Passage structures with assumed 10, 20, and 30% collection efficiencies.

ESTIMATES OF DETECTION PROBABILITY VERSUS PROPORTION SPILL

During development of the PITPH variable for The Dalles Dam and Bonneville Dam, the Ice and Trash Sluiceway (ITS) were combined with the turbine passage route in estimates of total powerhouse passage. The rationale for this decision was: 1) smolts enter the ITS in a similar manner as smolts entering bypass systems at the other dams, 2) smolts exiting the ITS follow a similar route in the tailrace as smolts that pass through the turbines, 3) smolts that use the ITS have similar tailrace egress times as smolts that pass through the turbines, and these tailrace egress times are approximately double those of smolts that pass via the spillway, and 4) smolts that exit the ITS pass near or through zones of high predator (northern pikeminnow and smallmouth bass) density in the tailrace, and this predator exposure is expected to be similar to smolts that pass through the turbines. Smolts that exit the corner collector at Bonneville Dam enter into the same area as smolts that pass through the spillways, unlike the ITS, where smolts enter areas directly adjacent to the turbine outfalls. For these reasons, the team believes that it is appropriate to combine the ITS route with the turbine route for quantifying total powerhouse passage.

Estimates of average proportion utilized in the 2019 CRSO analyses are provided in Table 1-14 below. These estimates reflect the modifications to the MO2 data set provided by the federal agencies on May 23, 2019. For the CSS life-cycle model, estimates of proportion transported were a function of the estimated cumulative PITPH at the three transportation projects (LGR, LGS, and LMN) and the specified start date for transportation at LGR and LGS. The NAA has transportation beginning on May 1, MO1 calls for transportation to begin on April 15th, and transportation would be initiated on April 25th for MO2 and MO4. No transportation will occur under MO3, which includes the measure of dam breach for the four lower Snake Dams.

Table 1-14. Mean estimates of proportion transported (95% confidence interval) for Chinook over the 80-year water record for each CRSO EIS Alternative used in the CSS life-cycle modeling

EIS Alternative	No PSP	PSP – 10% Efficiency	PSP – 20% Efficiency	PSP – 30% Efficiency
NAA	0.192 (0.176-0.208)	–	–	–
MO1	0.265 (0.243-0.288)	–	–	–
MO2	0.338 (0.314-0.363)	–	–	–
MO3 ^A	–	–	–	–
MO4 ^B	0.075 (0.071-0.079)	0.073 (0.069-0.076)	0.071 (0.068-0.074)	0.069 (1.066-0.071)

Notes: ^A With breach, no transportation is provided under M03.

^B M04 is the only alternative that proposes PSP at transportation sites. Therefore, this is the only alternative that had different estimates for proportion transported across the assumed 10%, 20% and 30% efficiencies.

1.5 TDG MODEL

The University of Washington TDG model uses outputs from the COMPASS model and the Corps water quality modeling to estimate juvenile survival and reach average exposure to TDG, average juvenile fish migration depth, and exposure timing.

1.5.1 Background and Introduction

Because high TDG levels can affect the health and survival of salmon (Weitkamp et al. 2008) the assessment of the gas exposure effects on fish is critical for assessing effects of the alternatives on salmon restoration efforts. This section describes a model to assess the relative impacts of hydrosystem operations on TDG generation and its effects on juvenile fish passing through the hydrosystem.

The TDG model uses the COMPASS smolt passage model (Zabel et al. 2008) to simulate the fish movement and TDG exposure based on flow, spill and TDG provided from models developed by other groups involved in the CRSO analysis. The model characterizes the effect TDG on juvenile fish passage with two metrics:

- 1) Mortality due to gas bubble disease
- 2) Reach Average TDG Exposure

The sections below describe the history of the model development, its conceptual framework, quantitative details, calibration and limitations, a brief user guide, example application and interpretation.

1.5.2 Model Development

The TDG model is essentially a standalone submodel of COMPASS. The TDG submodel system can generate TDG using inputs of flow and spill or it can accept TDG and hydraulic information from other models. For the CRSO analysis of TDG effects, two metrics are computed for each alternative: mortality from TDG exposure and average reach exposure. For the CRSO analysis, this model uses COMPASS results generated by NOAA using water quality inputs provided by the Corps water quality modeling group. In addition, a web-based TDG model is available so users can explore the model characteristics.

1.5.3 Conceptual Model

For each reach, TDG exposure of fish depends on travel time through the reservoirs and the TDG concentration while migrating through each of the reservoirs. Travel time depends on the water velocity and fish migration rate. The effective exposure is denoted as dissolved gas supersaturation (DGS). TDG in a reservoir depends on spill and the level of dissolved gas in the upstream reservoir (Figure 1-2). TDG levels are provided through the water quality modeling process for two locations in each reservoir: a high value at the tailrace of the upstream dam and a low value for the forebay of the downstream dam. Each metric is computed using the upstream and downstream set of TDG values. The survival and exposure metrics are then averaged to obtain the nominal metric value. The tailrace value represents an upper-bound for the reservoir gas level and the forebay values represents a lower-bound for the reservoir gas level. The metrics generated by these two bounds represent high and low exposure and

mortality calculated for each reach and over the entire hydrosystem. Note, the model only calculates the effects of TDG on mortality, other mortality processes are not included.

The model was developed from principles of dose-dependent mortality and empirical relationships for the effects of spill and flow on TDG levels and fish migration velocity. The mortality rate equation was developed from laboratory studies that determined the mortality rate of juvenile Chinook salmon exposed to constant levels of supersaturation (Dawley and Ebel 1975, Dawley et al. 1976). Depth of migrating fish was developed from field studies conducted at Snake and Columbia River dams (Stevens et al. 1980, Li et al. 2015a, Li et al. 2015b, Li et al. 2018).

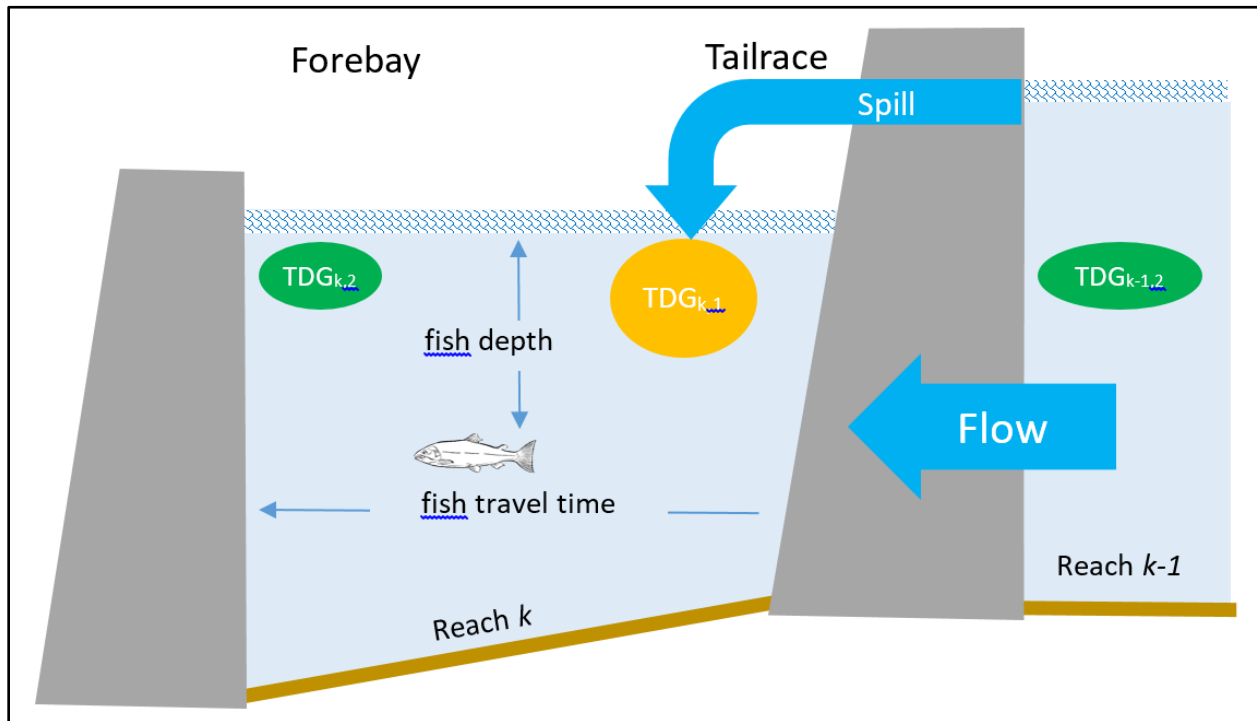


Figure 1-2. Conceptual model of factors determining TDG exposure and mortality of fish passing through a reservoir.

Reservoir TDG levels are supplied for the upstream (tailrace) and downstream (forebay) sections. Exposure indexes are calculated for each TDG level and then averaged. The upstream level $TDG_{k,1}$ depends on the amount of spill, powerhouse flow and the forebay levels in the upstream dam $TDG_{k-1,2}$. Direct GBD mortality depends on reservoir TDG levels, fish depth and fish travel time.

1.5.4 Quantification

This TDG modeling system provides a full hydrosystem representation of the effects of TDG on fish passage through reservoirs. The model represents a first order approximation of exposure and biological response. In terms of its spatial coverage it is the best system available. In the TDG model, fish movement components are calibrated for the entire hydrosystem (Zabel and Anderson 1997, Zabel et al. 1998) and the model integrates with the fish passage and hydraulic

models being used in the CRSO process. Finally, the TDG mortality equation is based on first principles of dose-response kinetics calibrated from laboratory studies.

The exposure metrics are detailed separately below. The development, calibration and validation of COMPASS is beyond the scope of this document, but the migration rate, location, passage tracking, and environmental conditions are essential to this analysis. To compute the TDG exposure metrics, detailed book-keeping of fish exposure to water properties is computed at 21 locations.

Programming languages used: COMPASS output processing is done with PERL for file manipulation and data extraction, and R for analysis, quantification and graphics display. Essential inputs include:

- 1) TDG data provided by the Corps on a daily basis over the 80-year hydrologic record, COMPASS migration rate inputs and fish releases for each hydrologic year, and assumptions on the modal depth of swimming for each species.

The output metrics are calculated from daily information on fish residence time in reservoirs and their associated TDG information.

1.5.4.1 Reach Average Exposure to TDG

Reach Average Exposure (RAE) is computed directly on COMPASS outputs where the number of fish passing and TDG level on each day are used to compute the reach exposure in reach k (RE $_k$). Next, a weighted average reach exposure is computed using the lengths of the reaches. For each hydrosystem operation alternative a single RAE metric is computed each year and species.

Equation 1. Reach Average Exposure Computations

$$RE_{k,i} = \sum_j^J TDG_{j,k,i} \cdot \frac{N_{j,k}}{TotalFish_k}$$

$$RAE_i = \frac{\sum_k RE_{k,i} \cdot \text{length}(reach_k)}{\sum_k \text{length}(reach_k)}$$

$$RAE = (RAE_1 + RAE_2) / 2$$

where:

j = first day of passage and J = last day of passage;

k = reach index (LGR = 0, LGS = 1 ... BON = 7);

i = TDG location with $i = 1$ upper reservoir location (tailrace), $i = 2$ lower reservoir location (forebay);

$TDG_{j,k,i}$ = total dissolved gas supersaturation level (above 100%) on day j in reservoir k and location i ;

and

$N_{j,k}$ = Number of fish in passing through reach k on day j .

The number of fish passing each reach is calculated from the COMPASS model using arrival time distributions of smolts at Lower Granite Dam. Each hydrologic year has a unique arrival time distribution that is fixed across the alternative operation scenarios.

1.5.4.2 Mortality Due to GBD

The computation of GBD bubble disease mortality involves assumptions and parameters from other studies. The following is excerpted from the CRISP1.6 Theory and Calibration manual available March 07 2019 at http://cbr.washington.edu/sites/default/files/manuals/crisp16_tc.pdf. CRISP was the predecessor to COMPASS and the functionality of this sub-model is retained in COMPASS. The methods are modified slightly from the original text to reflect current COMPASS model status. The computations presented below are embedded in the COMPASS code.

There is uncertainty as to the significance of GBD-induced mortality at low levels of supersaturation (<110%). Above that, the rate increases significantly. The transition between low levels of generally sublethal effects to the higher level lethal effects involves a shift in the bubble-related mechanisms that lead to death. Specifically, at levels of supersaturation below the threshold fish are more susceptible to death related to infection and stress while above the threshold fish experience death from large intravascular bubbles (White et al. 1991).

The level of total dissolved gas is generated by spill at the dams and then dissipated as the water moves downstream (Fig. 1). In the TDG model, the effects of lethal levels of TDG are considered. The difference in TDG exposure resulting from downstream gas dissipation in a reservoir is approached by averaging the exposures computed separately using the TDG from the tailrace of a reservoir's upstream dam and TDG from the forebay of a reservoir's downstream dam.

Assessing the effect of gas mortality involves six steps:

- 1) Define gas mortality rate for TDG level of a fish of a standardized length for a given depth.
- 2) Adjust the TDG to the depth of the fish.
- 3) Adjust the mortality rate for fish length.

- 4) Define the depth of the fish in the reservoir.
- 5) Integrate the mortality rates across fish depth distribution.
- 6) Calculate the reservoir survival resulting from gas bubble mortality.

1. DEFINE GAS MORTALITY RATE FOR TDG LEVEL OF A FISH OF A STANDARDIZED LENGTH FOR A GIVEN DEPTH.

The mortality rate for a specific level of TDG was determined for juvenile Chinook salmon and steelhead using data which tracked the mortality of fish over time using tanks with different depths (Dawley and Ebel 1975, Dawley et al. 1976). The lethal effect of TDG were greater in the 0.25 m tanks than the 2.5 m tanks. However, the mortality in the two configurations were similar exhibiting a linear slow rate of mortality at low TDG levels and a transition to higher mortality rate once the TDG had exceeded a critical level TGD_c .

The model characterizes this transition in mortality rate with a piecewise linear function that expresses the rate of mortality M' as a function of the extra gas supersaturation using a Heaviside function $H()$ (Figure 1-3). This allows the model to assume a moderate linear increase in mortality (slope = a) at low levels of gas supersaturation and when the lethal threshold of saturation TGD_c is reached, the Heaviside function turns on and the mortality curve increases linearly with a higher rate (slope = $a + b$). Using Dawley and Ebel (1975), the empirical gas mortality rate equation is:

Equation 2. Defining Gas Mortality Rate for TDG level, length, and depth.

$$M(TDG, z) = a \cdot (TDG - m \cdot z) \cdot H(TDG - m \cdot z) + b \cdot (TDG - m \cdot z - TDG_c) \cdot H(TDG - m \cdot z - TDG_c)$$

where

M = base gas bubble mortality rate for standard fish,

TDG = level of gas supersaturation at the surface,

TGD_c = critical threshold at which the mortality switches to a higher rate,

m = decrease in TDG with fish depth z ,

a = species-specific gas mortality rate coefficient with units of TDG-1 day-1 determining the initial rate of increase of mortality per %-increase in TDG,

b = species-specific gas mortality rate coefficient with units of TDG-1 day-1, determining the increase of mortality per %-increase in TDG above TGD_c , and

$H()$ = Heaviside function, also known as the unit step function; equal to zero when its argument is negative and one when its argument is positive.

Table 1-15. Mortality rate coefficients

Parameter	Spring Chinook	Steelhead
a	0.000021	0.000594
b	0.005980	0.004820
TDG_c	10.9	12.7

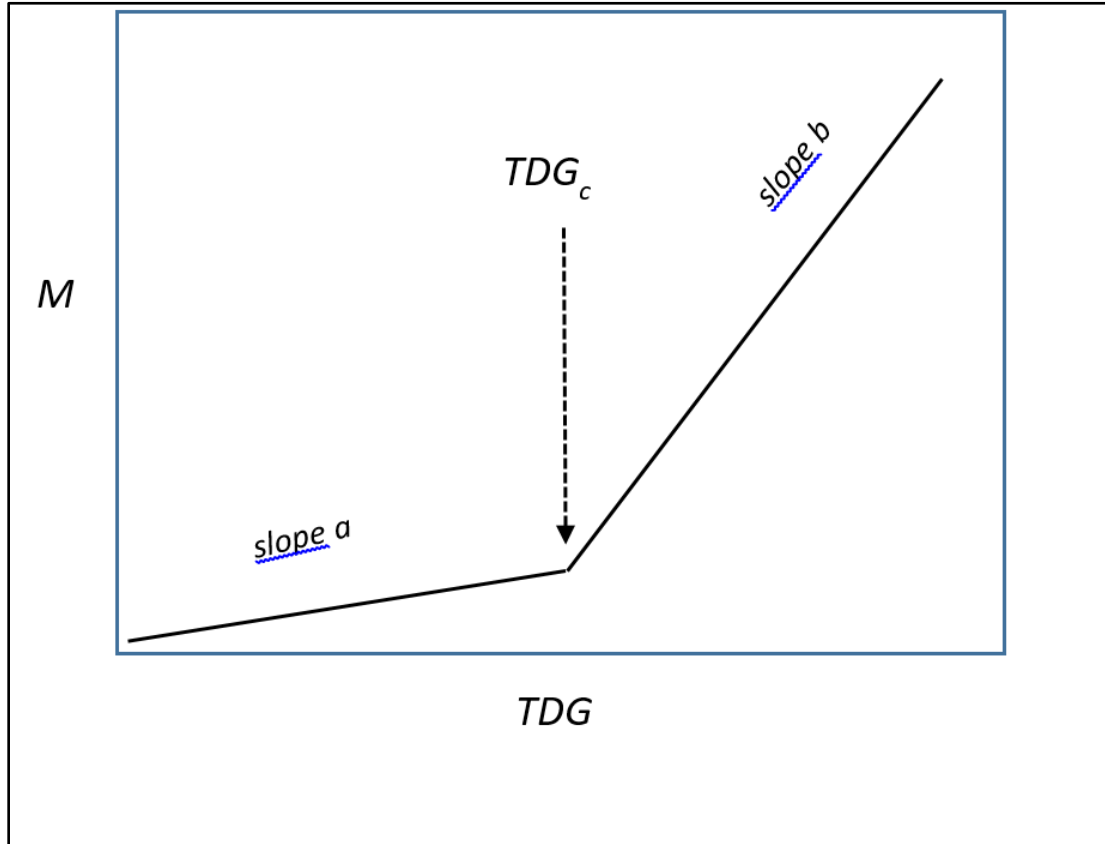


Figure 1-3. Dissolved gas mortality rate equation for total dissolved gas level TDG

Using Dawley survival data for fish exposed under 40 days; the parameters a and b were fit using linear regression (Table 1-15). The underlying data for the analysis is given in (Tables 1-16 and 17).

The mortality rate also appears to exhibit an exposure duration threshold that suggests that TDG compensatory mechanisms are functional for a period of time and then begin to break down. As a result, fish exposed to for up to 2 months or more in the Dawley experiments were susceptible to mortality at a higher rate than fish exposed for a short period of time. The model used data for fish exposed for 40 days or less, on the order of time that the fish are exposed in the river system. This subset of the mortality data was used to determine the TDG mortality coefficients.

Table 1-16. Chinook mortality rates

%TDG	Days (t)	0.25m Survival (S)	0.25m Mortality rate (M)	2.5m Survival (S)	2.5m Mortality rate (M)
105	20	0.99	0.0005	1	0
105	40	0.98	0.00051	1	0
105	60	0.97	0.00051	0.99	0.00017
105	80	0.9	0.0013	0.97	0.00038
105	100	0.88	0.0013	0.97	0.0003
105	120	0.87	0.0012	0.96	0.00034
115	10	0.95	0.0051	–	–
115	20	0.84	0.0087	1	0
115	30	0.72	0.011	–	–
115	40	0.62	0.012	1	0
115	50	0.49	0.014	–	–
115	60	0.22	0.025	0.97	0.00051
115	70	0.12	0.03	–	–
115	80	0.08	0.032	0.88	0.0016
115	100	0.05	0.03	0.83	0.0019
115	120	–	–	0.78	0.0021
120	10	0.77	0.026	–	–
120	20	0.57	0.028	1	0
120	30	0.32	0.038	–	–
120	40	0.22	0.038	1	0
120	50	0.1	0.046	–	–
120	60	0.03	0.058	0.95	0.00085
120	70	0.02	0.056	–	–
120	80	0.01	0.058	0.71	0.0043
120	100	–	–	0.64	0.0045
120	120	–	–	0.58	0.0045
127	10	–	–	0.97	0.003
127	20	–	–	0.88	0.0064
127	30	–	–	0.7	0.012
127	40	–	–	0.52	0.016
127	60	–	–	0.38	0.016
127	80	–	–	0.1	0.029
127	100	–	–	0.07	0.027

Notes: *0.25m = shallow tank experiments; **2.5m = deep tank experiments.

Source: (Dawley and Ebel 1975, Dawley et al. 1976)

Table 1-17. Steelhead mortality rates based on survival data and mortality rates

%TDG	Days (t)	0.25m Survival (S)	0.25m Mortality Rate (M)	2.5m Survival (S)	2.5m Mortality Rate (M)
105	1	1	0	1	0
105	2	1	0	1	0
105	3	—	—	1	0
105	4	—	—	1	0
105	5	0.96	0.0082	1	0
105	6	—	—	1	0
105	7	0.95	0.0073	—	—
110	1	1	0	1	0
110	2	1	0	1	0
110	7	0.97	0.0044	0.99	0.0014
115	1	1	0	1	0
115	2	0.95	0.026	—	—
115	3	0.7	0.12	1	0
115	4	0.58	0.14	—	—
115	5	0.48	0.15	—	—
115	6	0.41	0.15	—	—
115	7	0.37	0.14	0.97	0.0044
120	0.8	0.76	0.34	—	—
120	1	0.67	0.4	—	—
120	1.2	0.42	0.72	—	—
120	1.9	0.060	1.5	—	—
120	2	—	—	0.99	0.005
120	3	—	—	0.96	0.014
120	7	—	—	0.94	0.0088
127	2	—	—	0.92	0.042
127	3	—	—	0.87	0.046
127	4	—	—	0.82	0.05
127	5	—	—	0.8	0.045
127	6	—	—	0.77	0.044
127	7	—	—	0.75	0.041

Notes: *0.25m = shallow tank experiments; **2.5m = deep tank experiments.

Source: (Dawley and Ebel 1975, Dawley et al. 1976)

2. TDG DEPTH CORRECTION FACTOR M

Fidler and Miller (1994) and Dawley and Ebel (1975) demonstrated that the critical supersaturation threshold increases at greater depth. The experiments indicated that mortality curves in shallow tanks at 112% saturation were equivalent to mortality curves in a deep tank with 122% supersaturation. Based on the mechanisms controlling partial pressures of gas bubbles, the partial pressure increases approximately 10% per meter below the surface (Richards 1965). Fidler and Miller (1994) noticed a linear change in the threshold depth for gas

bubble trauma symptoms giving the correction factor. The slope of this linear relationship is 73.89 mmHg m⁻¹, and given the relationship of TDG to pressure (0.1316 %/ mmHg), this is equivalent to m = 9.72 m⁻¹ or m = 2.96 ft⁻¹.

3. SIZE-MORTALITY RATE RELATIONSHIP

The Dawley and Ebel (1975) study demonstrated that large fish had higher levels of mortality. The experiments exposed fall chinook of various sizes to 112% supersaturation in shallow tanks and determined the cumulative mortality curves varied with size (Dawley and Ebel 1975, Fig. 10). These data were then used to infer the effect of fish length on TDG mortality in reservoirs.

The resulting mean mortality rates are plotted against fish length (Fig. 1-4). The slope of the line relating mean mortality rate to length is 0.00126. The regression was not confined to go through zero because Dawley and Ebel (1975) and Jensen et al. (1986) both report that there is a sensitivity threshold for size. The cumulative mortality over time for the different fish sizes is illustrated in Fig. 1-5.

The ability of a fish to establish gas equilibrium should be related to its volume to surface area ratio, which is proportional to fish length. Thus, on physical principles of gas exchange, a length relationship should affect TDG mortality. For a first order estimate of the length relationship to mortality rate is:

Equation 3: First order estimate of Fish Length relationship to mortality rate

$$M(L) = \alpha + \beta * L$$

Where:

$M(L)$ = effective gas bubble mortality rate as a function of fish length,

L = fish length in mm,

β = 0.0012 mm⁻¹, length coefficient for TDG mortality rate (regression of all data from the 112% shallow tank experiments (Dawley et al. 1976), and

α = intercept mortality rate in which the effects of fish depth and TDG exposure are inferred

The mortality rate is corrected for fish length from the laboratory studies to the field example using:

Equation 4: Mortality Rate Corrected by Fish Length

$$M(L) = M(L_e) \cdot (L + c) / (L_e + c)$$

where

L = length of fish in environment, and
 L_e = length of fish in TDG mortality experiments.

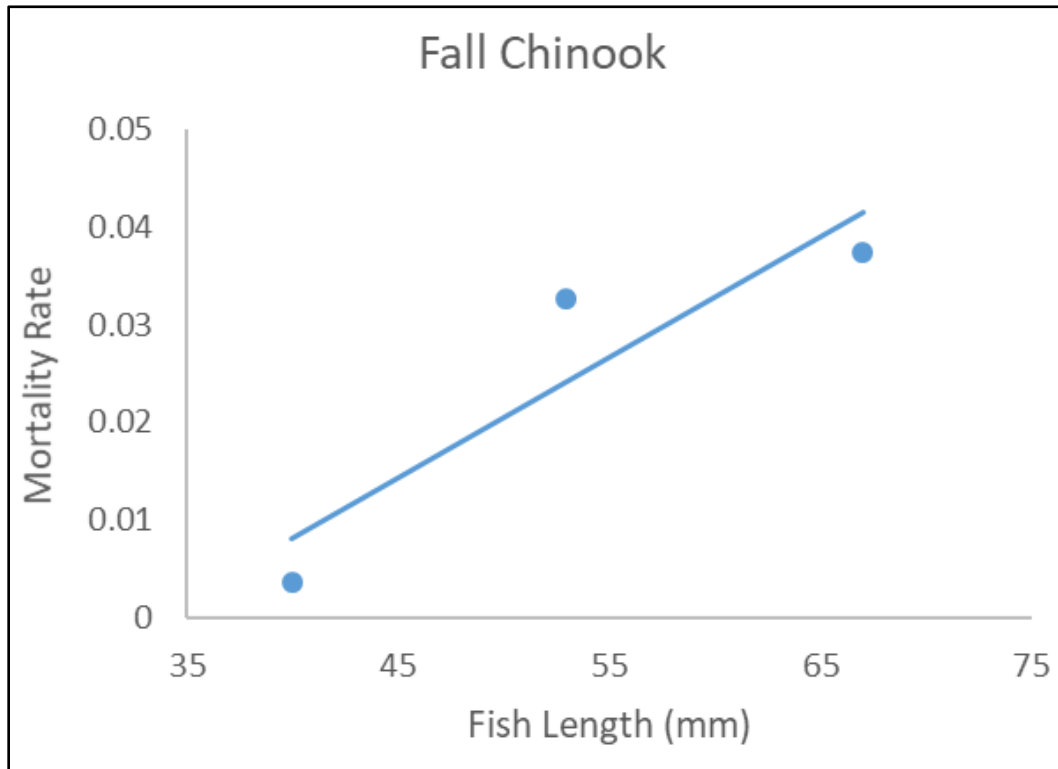


Figure 1-4. Relationship of mortality rate with fish length

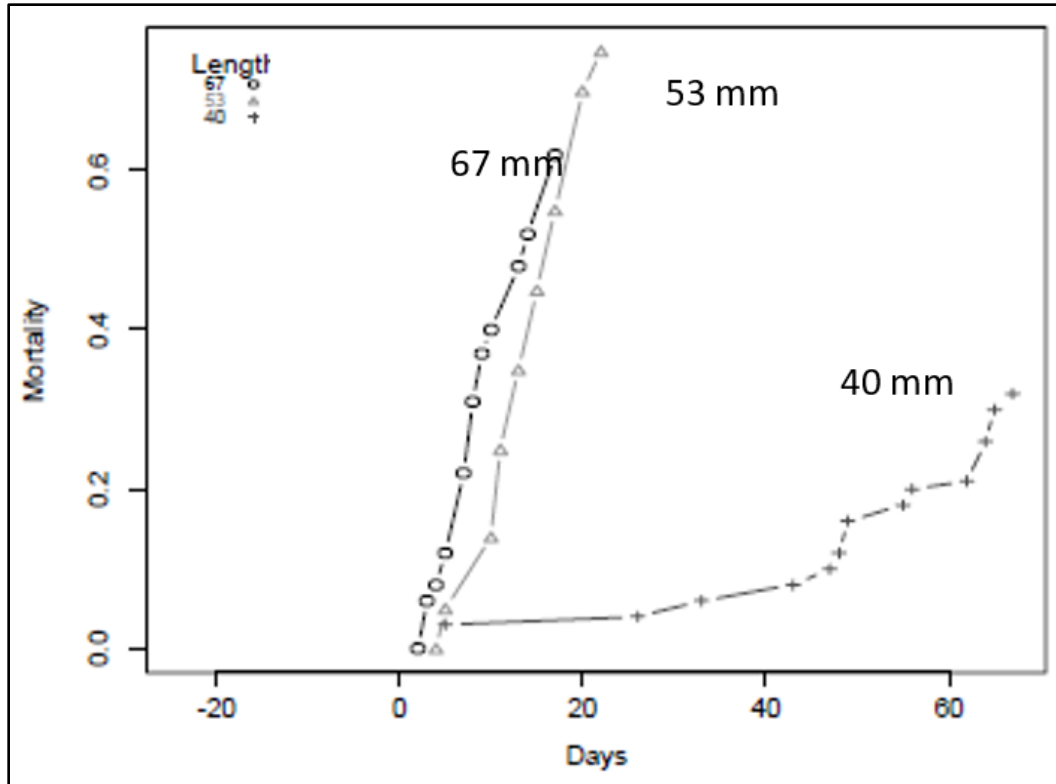


Figure 1-5. Cumulative mortality vs. exposure time to TDG supersaturation (112%) for different fish lengths

4. FISH VERTICAL DISTRIBUTION

Fish from a given species will distribute vertically (Figure 1-6). A number of distribution functions have been hypothesized (Zabel 1994). For simplicity the team uses an isosceles triangular distribution to define the fish density with depth (Fig. 1-5):

Equation 5: Computing Fish Vertical Distribution

$$Dist(z) = H(z_D - z) \cdot \left(m_0 \cdot z \cdot H(z) + (m_1 - m_0) \cdot (z - z_0) \cdot H(z - z_m) - m_1 \cdot (z - z_b) \cdot H(z - z_b) \right)$$

where

z = fish depth,

z_D = depth of the reservoir,

z_b = maximum depth of fish distribution,

z_m = mode of fish distribution,

m_0 = slope of distribution function above mode, and

m_1 = slope of distribution function below mode.

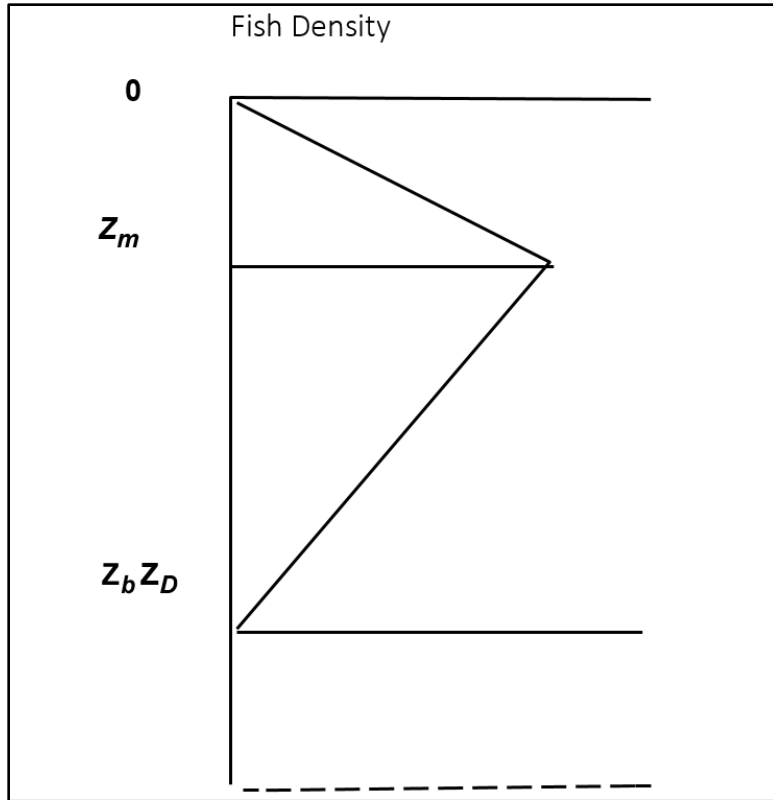


Figure 1-6. Illustration of fish depth distribution of fish

The gas bubble disease rate depends on fish depth which is characterized by a mode depth and bottom depth. Fish depths vary continuously over day and night, fish age, and position in the river. For the current model, depth parameters are required for each species which are derived from the literature (Table 1-18).

Table 1-18. Fish vertical distributions and references

Species	Location	Time	Mode depth (m or ft)	Reference
Spring Chinook	Forebay	Day	39 ft 5 ft 2.6 -12.2 m	(Ebel and Raymond 1976, Johnson et al. 1985, Li et al. 2015a, Li et al. 2015b, Li et al. 2018)
Spring Chinook	Reservoir	Day	12-24 ft 27-36 ft	(Smith 1974, Dauble et al. 1989)
Spring Chinook	Reservoir	Night	0-12 ft 27-36 ft	(Smith 1974, Dauble et al. 1989)
Spring Chinook	McNary Pool	–	1.5 – 3.2 m	(Beeman and Maule 2006)
Steelhead	Forebay	Day	13 ft 4 ft 2.6 – 12.2 m	(Ebel and Raymond 1976, Johnson et al. 1985, Li et al. 2015a, Li et al. 2015b, Li et al. 2018)
Steelhead	Forebay	Night	–	–
Steelhead	Reservoir	Day	0-12 ft	(Smith 1974)
Steelhead	Reservoir	Night	12-24 ft	(Smith 1974)

Species	Location	Time	Mode depth (m or ft)	Reference
Steelhead	McNary Pool		2 -2.3 m	(Beeman and Maule 2006)

Note: CRSO analysis selected values: Mode = 7 ft. Maximum = 50 ft. for all rows

5. AVERAGE MORTALITY RATE THROUGH RESERVOIR

A reservoir average mortality rate per day is created by calculating the depth weighted average as

Equation 6: Average mortality per day (Depth Weighted Average)

$$M_{j,k,i} = \int_0^{z_D} Dist(z) \cdot M(TDG_{j,k,i}, z, L)_{j,k,i} dz$$

With:

$$M_{j,k} = (M_{j,k,1} + M_{j,k,2}) / 2$$

Where:

$M_{j,k}$ = average gas bubble mortality for day j in reservoir k,

$M_{j,k,i}$ = average gas bubble mortality for day j in reservoir k using TDG from reach location I,

$TDG_{j,k,i}$ = surface total dissolved gas supersaturation level on day j in reach k and reservoir location I,

L = fish length in environment, and

z = fish depth in reservoir.

6. RESERVOIR SURVIVAL ASSOCIATED WITH GB

The reservoir survival resulting from gas bubble disease only is defined is:

Equation 7: Survival with Gas Bubble Disease

$$S_{j,k} = \exp(-M_{i,k} \cdot t_{j,k})$$

Where:

$S_{j,k}$ = survival without predation in reservoir k on day j,

$M_{j,k}$ = TDG mortality rate at a specific level of supersaturation in reservoir k on day j, and

$t_{j,k}$ = exposure time in reservoir k on day j.

Evaluation

The TDG metrics characterize the impacts to fish at different levels of specificity. The reach average involves a model of physical production of TDG and a biological model of the travel time of fish through reservoirs. The TDG production model (RESSIM) was developed by the Corps group and the fish travel time model was developed by the University of Washington (Zabel 1994) and consequently refined and further calibrated by NOAA (Zabel et al. 2008). The fish mortality metric applies the TDG exposure metrics to model the direct mortality due to

the exposure. This metric has additional levels of uncertainty because the rate of mortality requires dissolved gas supersaturation (DGS), which depends on fish depth. These metrics provide a numerical ranking of the impacts of alternative hydrosystem operations on exposure of juvenile migrants. The relationships of the metrics to actual direct and latent mortality resulting from TDG exposure have not been determined.

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CHAPTER 2 - CONCEPTUAL ECOLOGICAL MODELS

2.1 INTRODUCTION

2.1.1 Conceptual Ecological Models

Conceptual ecological models (CEMs) are non-quantitative planning tools that identify the major drivers and stressors on natural systems and sensitive populations. The ecological effects of these stressors and the best predictive attributes or metrics of these ecological responses are used to evaluate effects of potential actions in the system. CEMs can be used with any ecological restoration and conservation program and can become a communication, planning, and assessment tool for decision making and alternative evaluation. A set of CEMs has been developed for listed and sensitive fish species within the Columbia River basin as a tool for conducting qualitative evaluations of the effects of alternatives on these fish species. CEMs were created for species that were either listed under the Endangered Species Act or were identified as species of concern within the watershed. These include:

Anadromous Species

Spring/Summer-Run Chinook

Fall-Run Chinook

Steelhead

Sockeye

Coho

Chum

Pacific Lamprey

Eulachon

Green Sturgeon

Resident Species

Bull Trout

Kootenai River White Sturgeon

Burbot

Redband Rainbow Trout

Westslope Cutthroat Trout

White Sturgeon

Each CEM was built from extensive literature reviews that document the processes that drive the relationships between critical life stages and the habitat elements for each fish and show

how controlling factors ultimately influence these critical life history stages. Line thickness in the CEM shows the strength of the relationship, while line color shows the current understanding of the relationship. Reference sections for each species are also included.

How to Read a CEM: Become familiar with the CEM from the bottom up, and then follow the arrows from the top down. The bottom row of boxes (in gold) indicate the life stages that an individual of the species must successfully complete in order to move on to the next stage and ultimately complete its life history and contribute to the population. The next row (green boxes) above these life history boxes are biological processes that affect that individual's ability to complete the life history outcome of the boxes below them. The third row up (pink boxes) represent habitat elements that influence the life history elements. Habitat elements can be either an element necessary to a life stage, or one that affects the success of that life stage either adversely or beneficially. Finally, the blue boxes in the top row indicate the controlling factors, or drivers, that determine or affect the habitat elements. Arrows in the model are the links showing the flow of influence from drivers to habitat elements to critical processes, and finally to life stage success. Three different line thicknesses are used to indicate high, medium, or low magnitude of effect or influence, and the color of the line indicates the level of understanding, or scientific certainty, of that particular link. Note that links can also flow between boxes in the same row if, for example, one driver influences another. For a simple example, in the Spring/Summer Chinook salmon CEM below, the controlling factor "Hydrosystem Structures and Operations" influence the habitat element "Physical Barriers" that can impede "Habitat Access" and "Upstream Migration" processes necessary for an adult to complete "Return Migration" and "Spawning".

It is important to note that the CEMs include all controlling factors (both human-caused and natural) that affect the species to give a sense of the "big picture" of effects; the scope of the EIS analyses, however, is focused on only those controlling factors that are determined by the configuration and operation of the CRS. CEMs were developed on a general scale at the species level. While it would be very difficult and time-consuming to develop these at a more local or regional scale, they serve as a good starting point for developing relationships of environmental factors that can be controlled by the CRS and may change under the various alternatives and how that may affect fish at the ESU/DPS or the fish community level. This is the basis of the qualitative analyses used in this EIS.

The remainder of this section are the CEMs that were developed in this process, followed by the references used to inform the process.

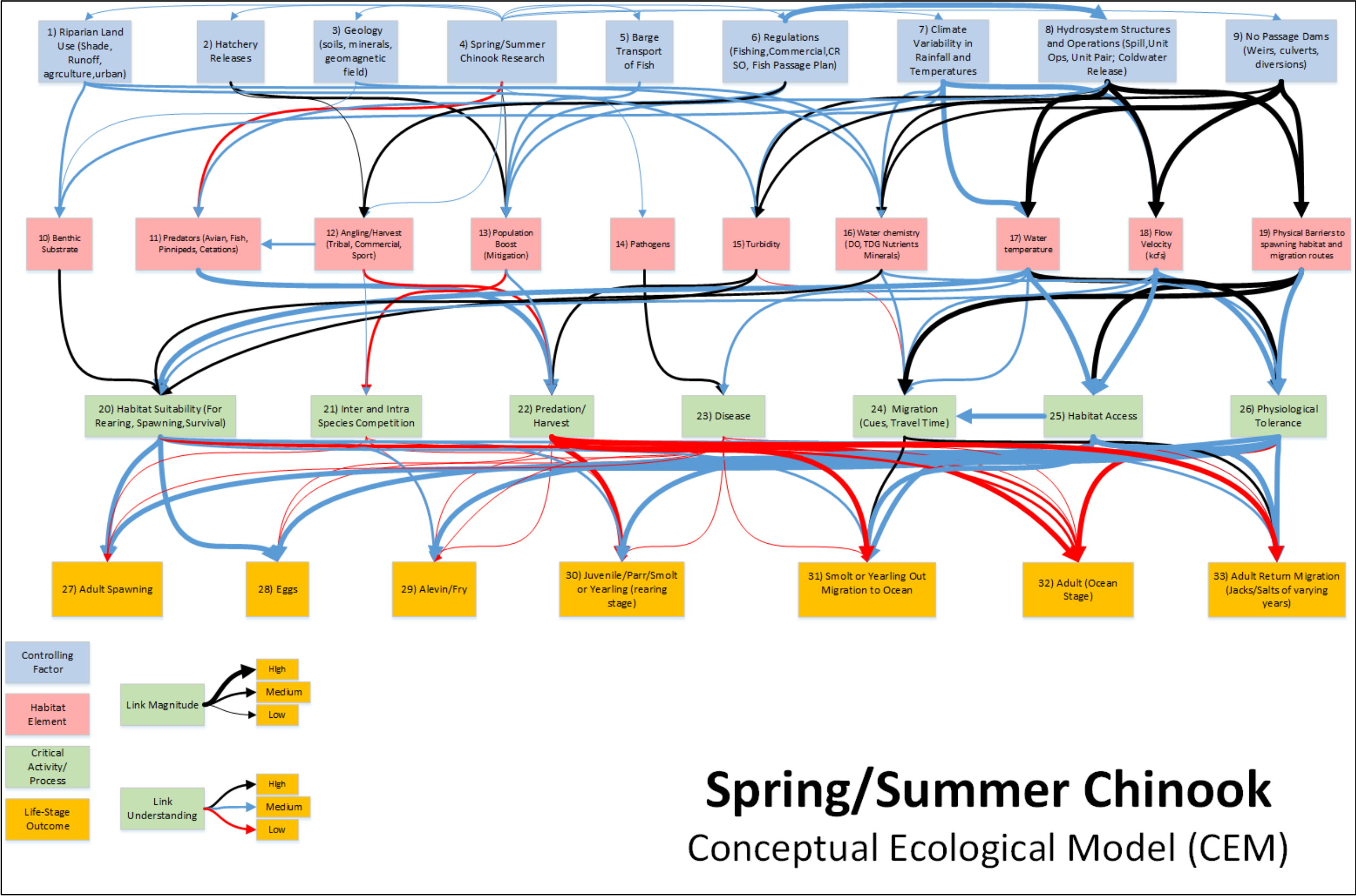


Figure 2-1. General Conceptual Ecological Model for Spring/Summer Chinook Salmon.

2.2 SPRING/SUMMER CHINOOK CEM REFERENCES

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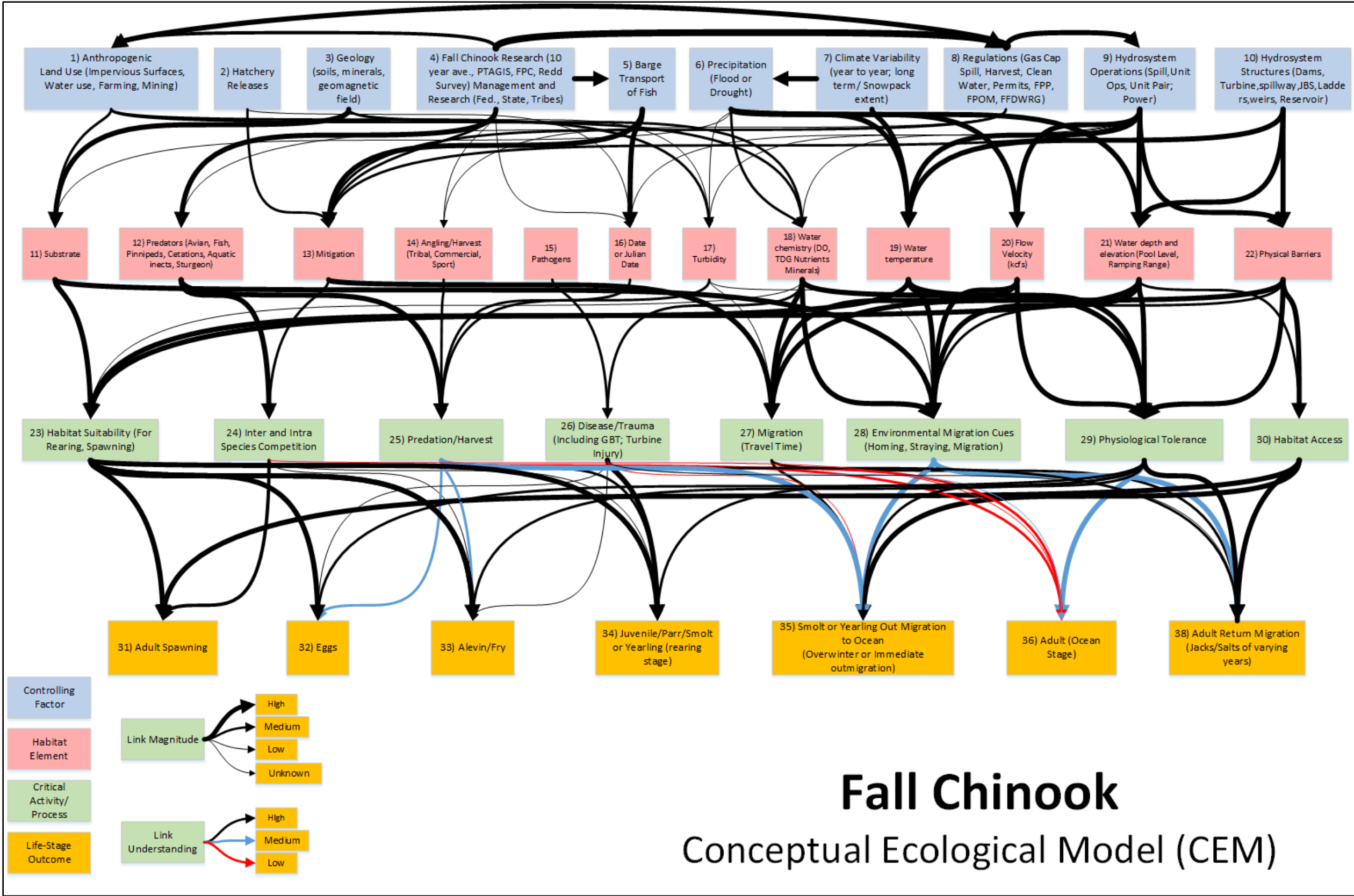


Figure 2-2. General Conceptual Ecological Model for Fall Chinook Salmon

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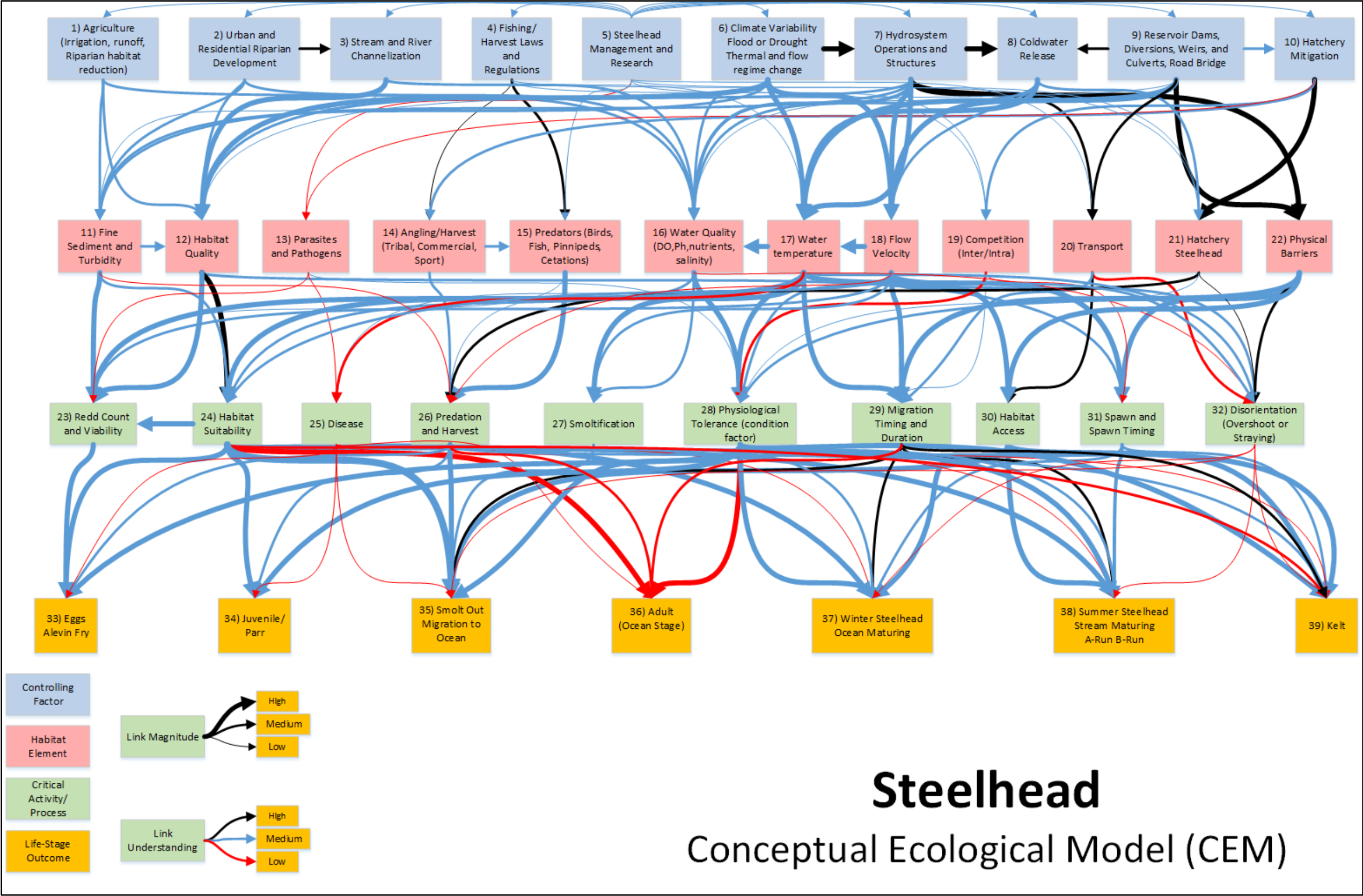


Figure 2-3. General Conceptual Ecological Model for Steelhead

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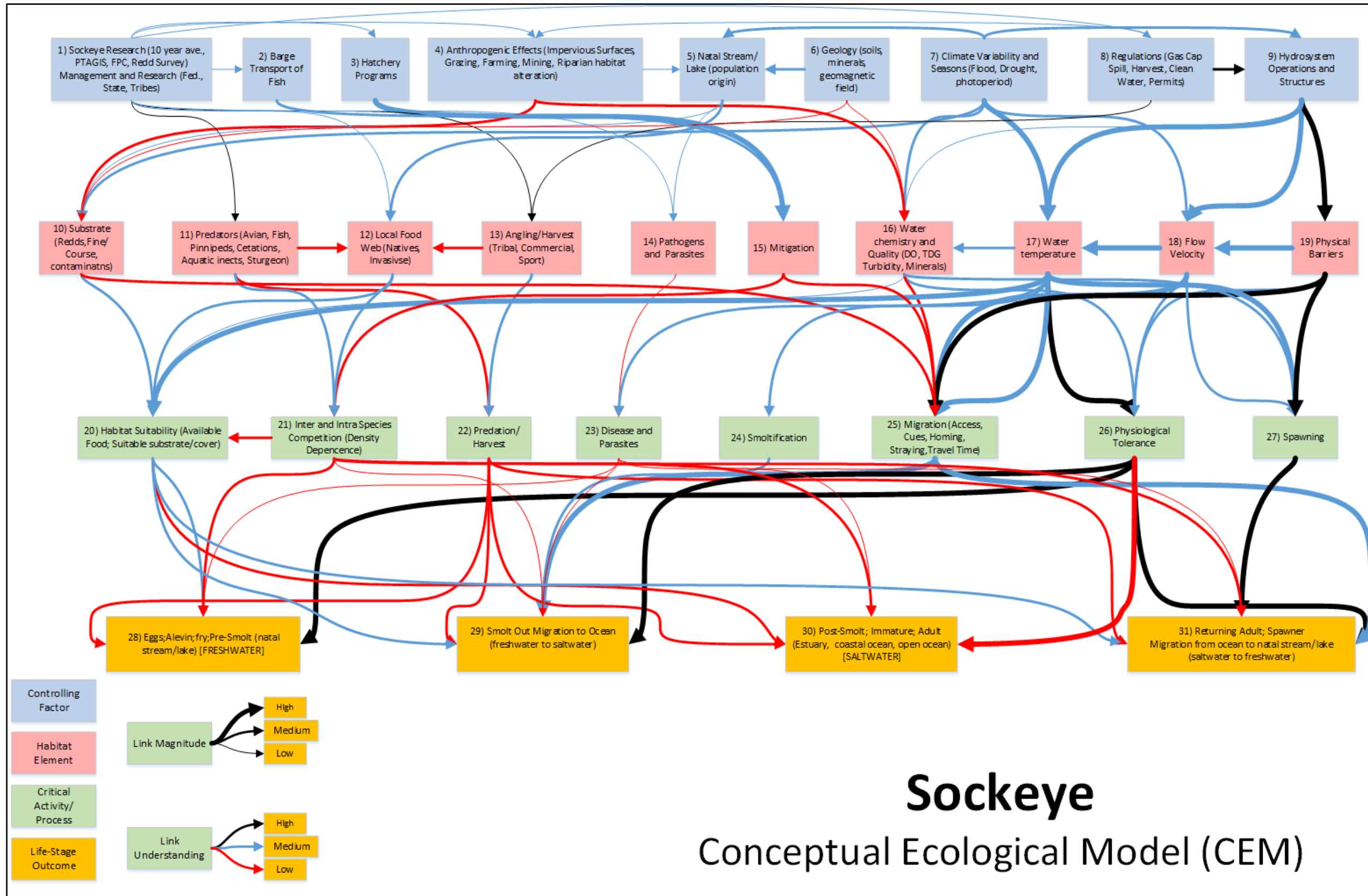


Figure 2-4. General Conceptual Ecological Model for Sockeye Salmon

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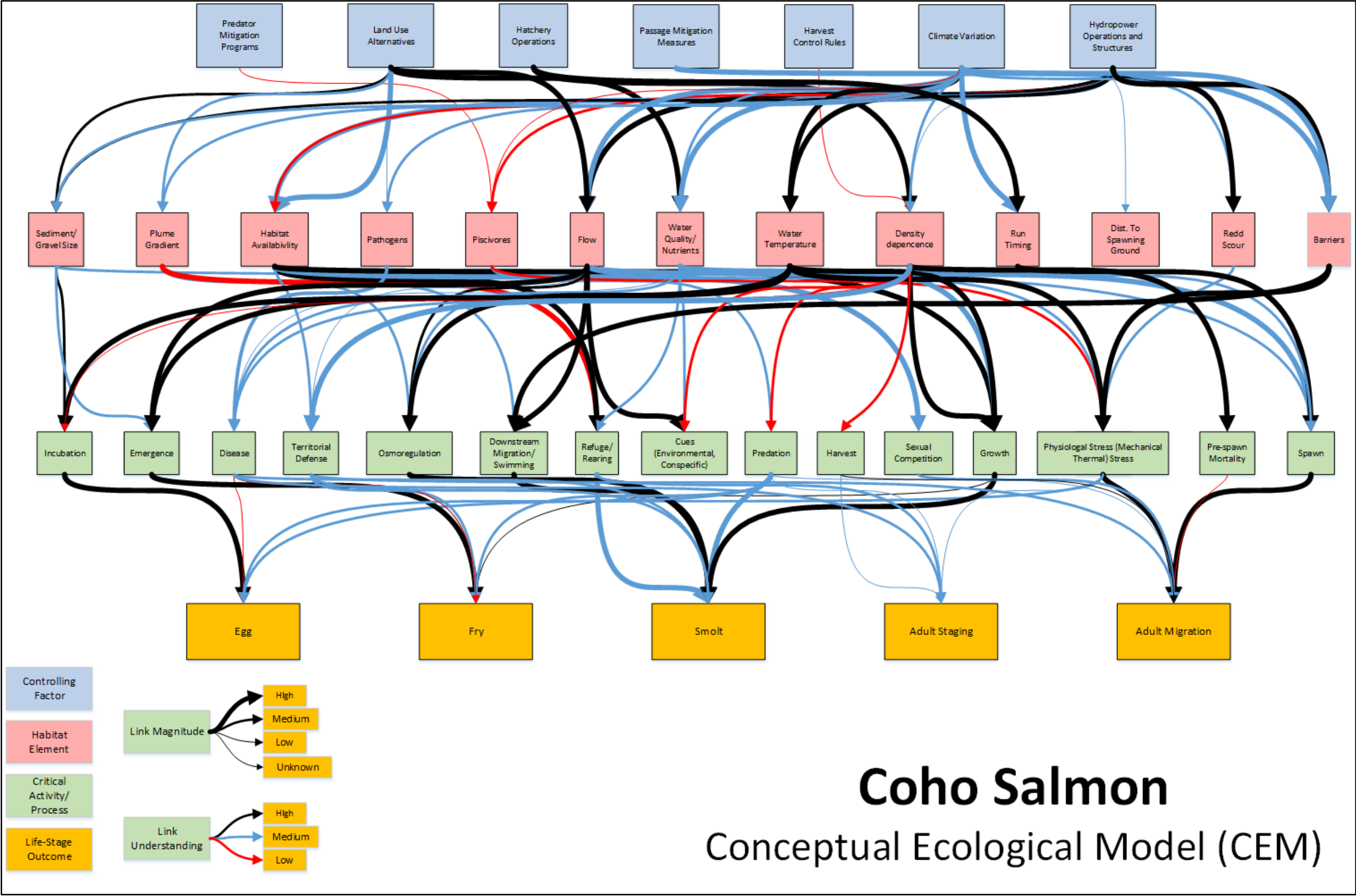


Figure 2-5. General Conceptual Ecological Model for Coho Salmon

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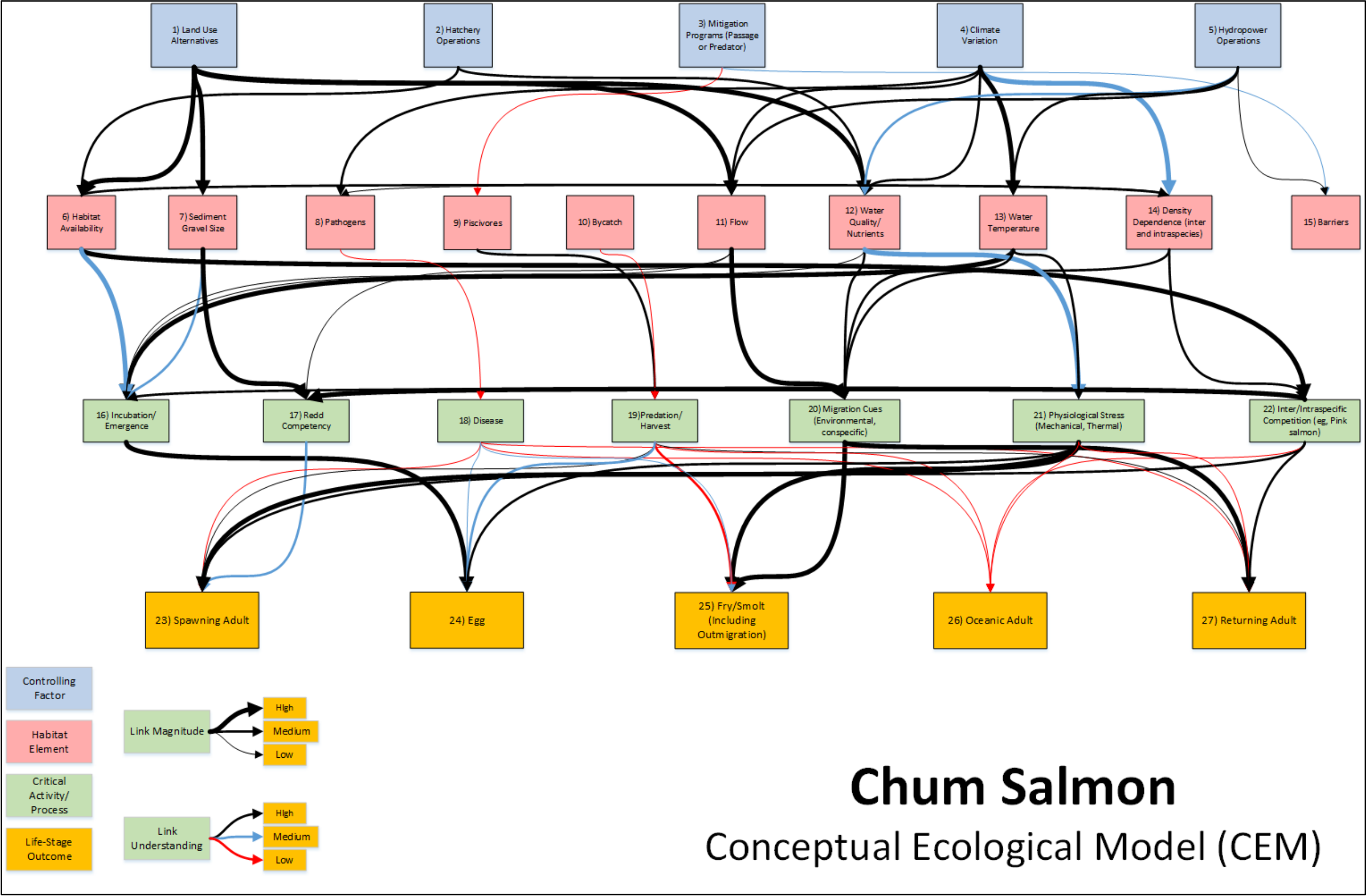


Figure 2-6. General Conceptual Ecological Model for Chum Salmon

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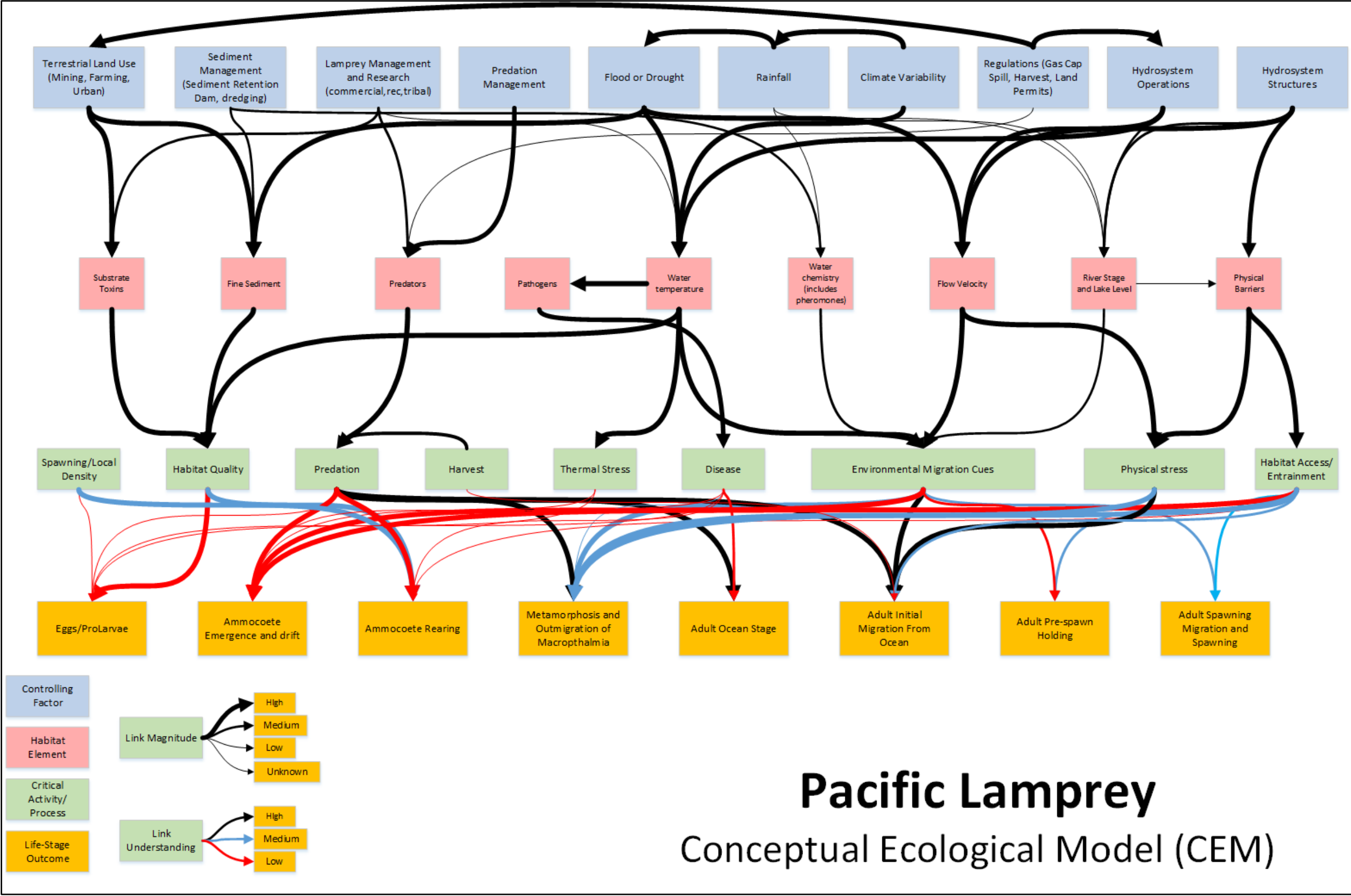


Figure 2-7. General Conceptual Ecological Model for Pacific Lamprey.

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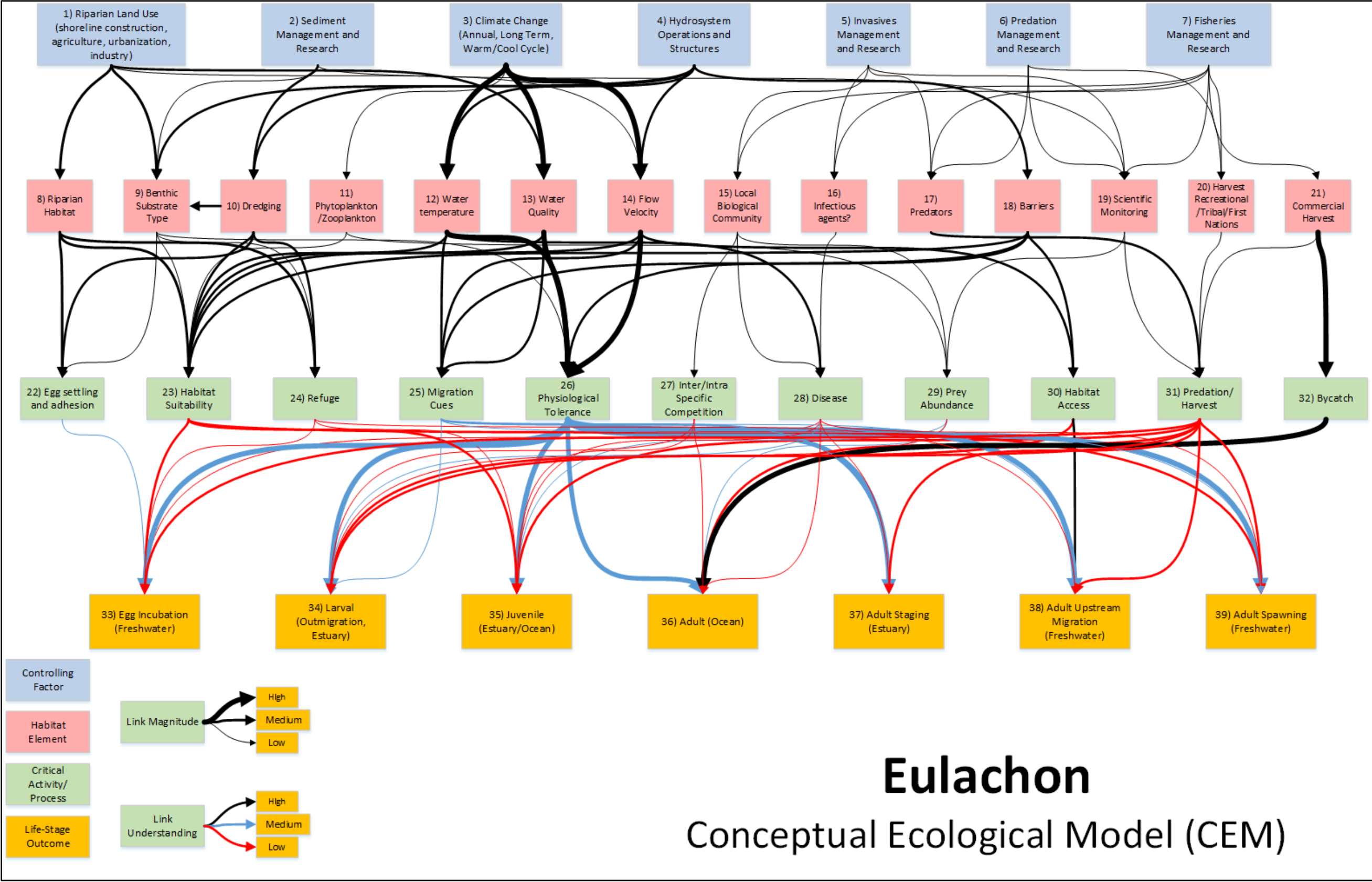


Figure 2-8. General Conceptual Ecological Model for Eulachon.

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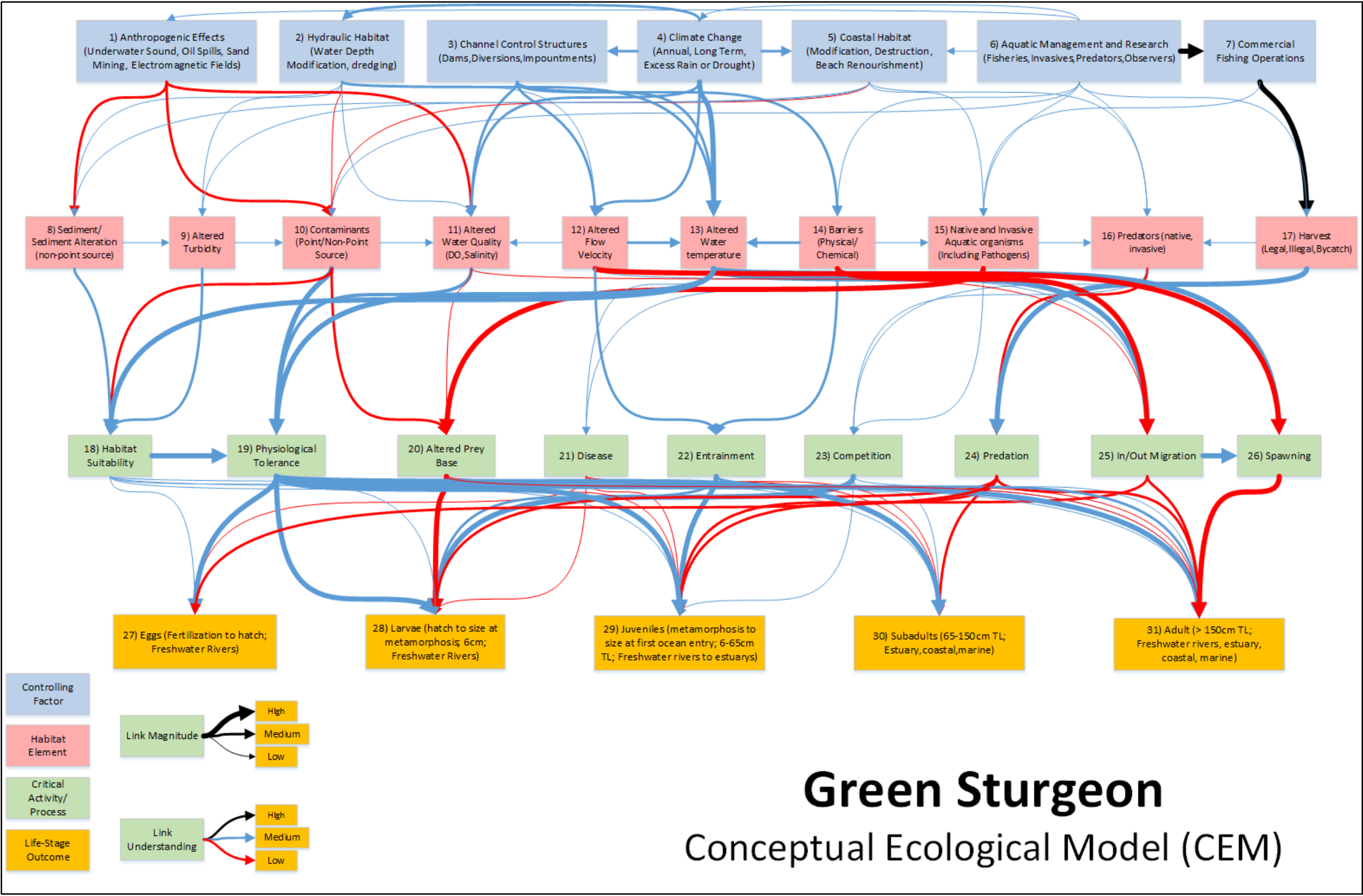


Figure 2-9. General Conceptual Ecological Model for Green Sturgeon

2.10 REFERENCES FOR GREEN STURGEON CEM

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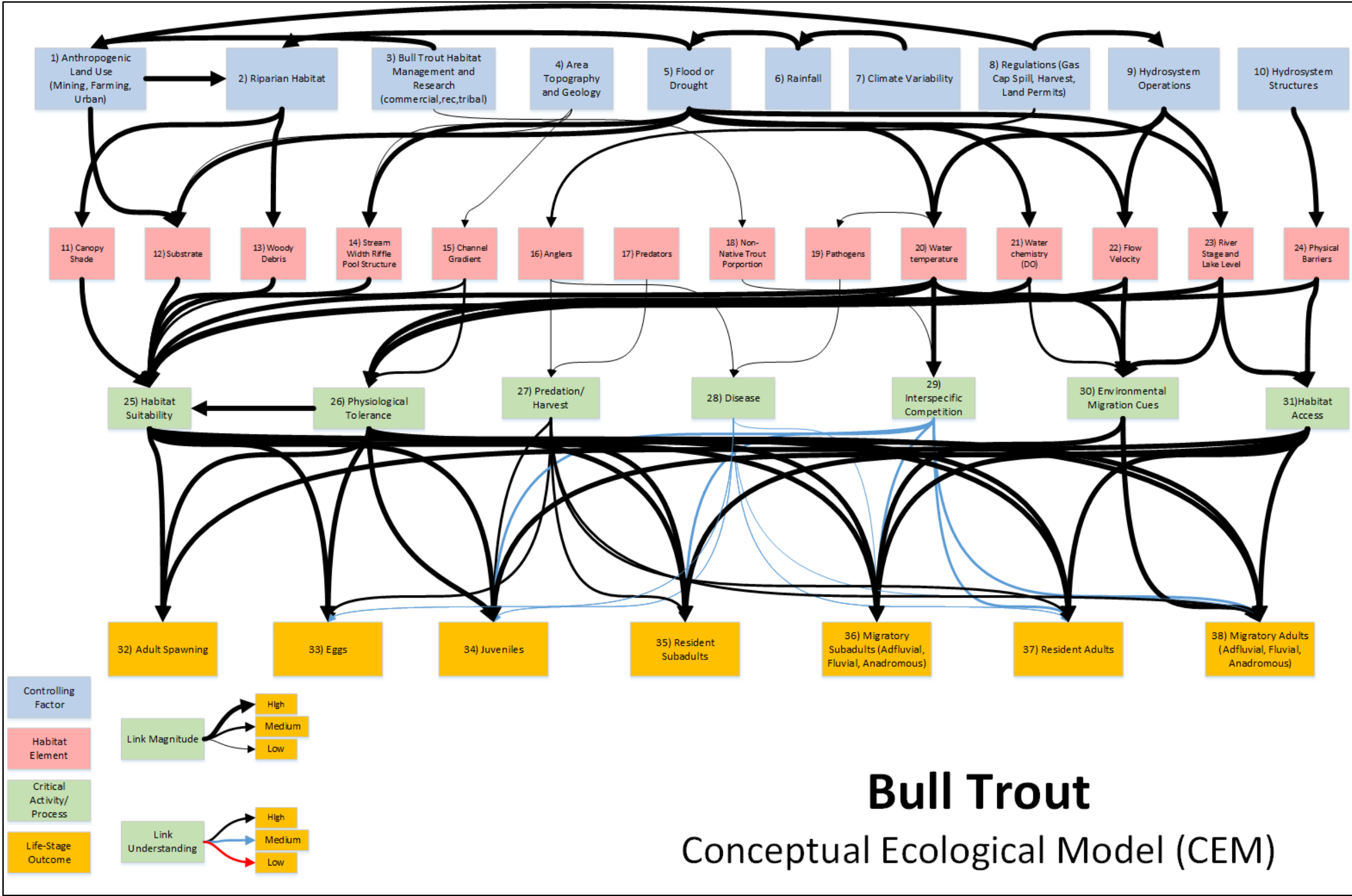


Figure 2-10. General Conceptual Ecological Model for Bull Trout.

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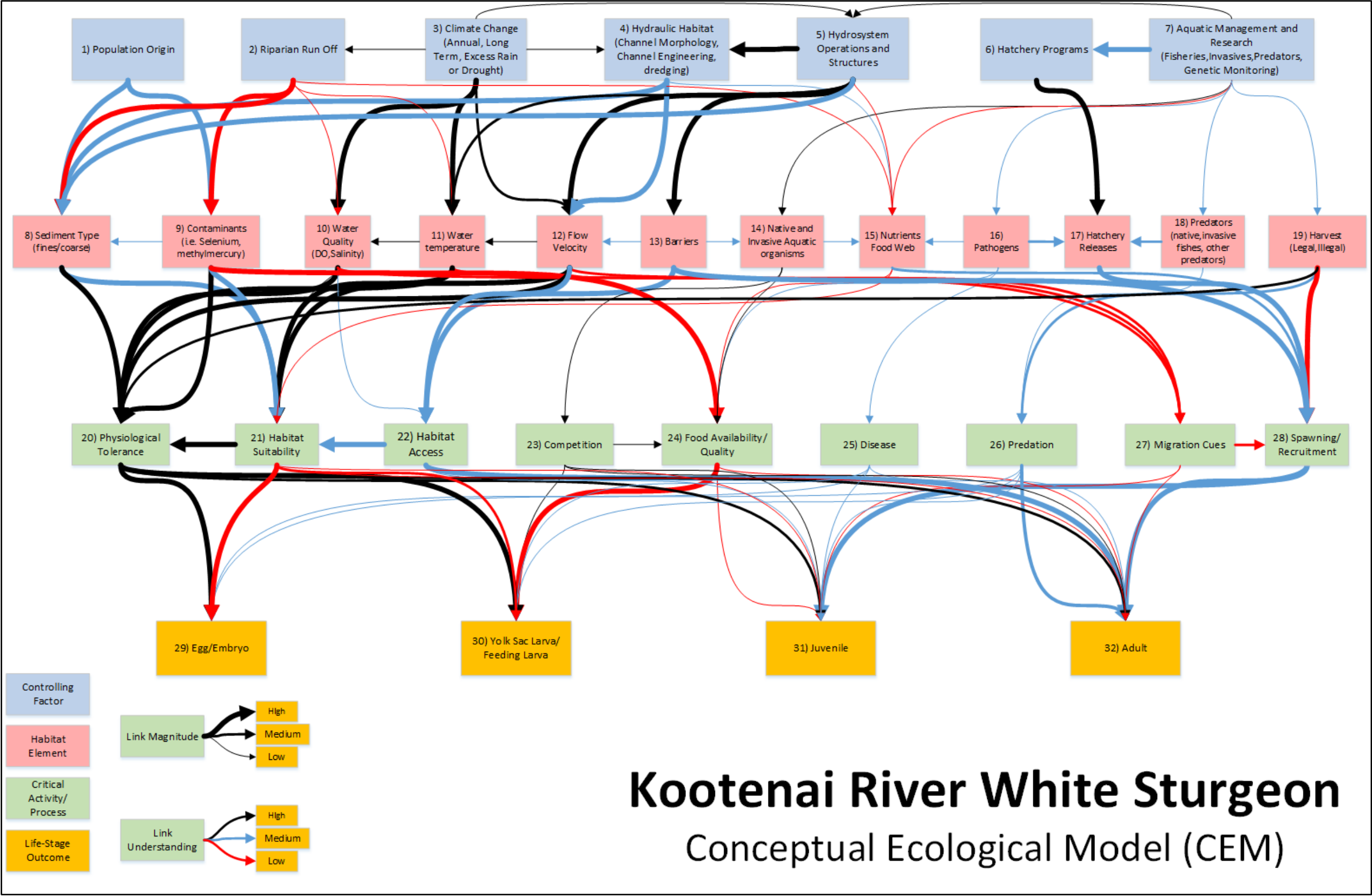


Figure 2-11. General Conceptual Ecological Model for Kootenai River White Sturgeon.

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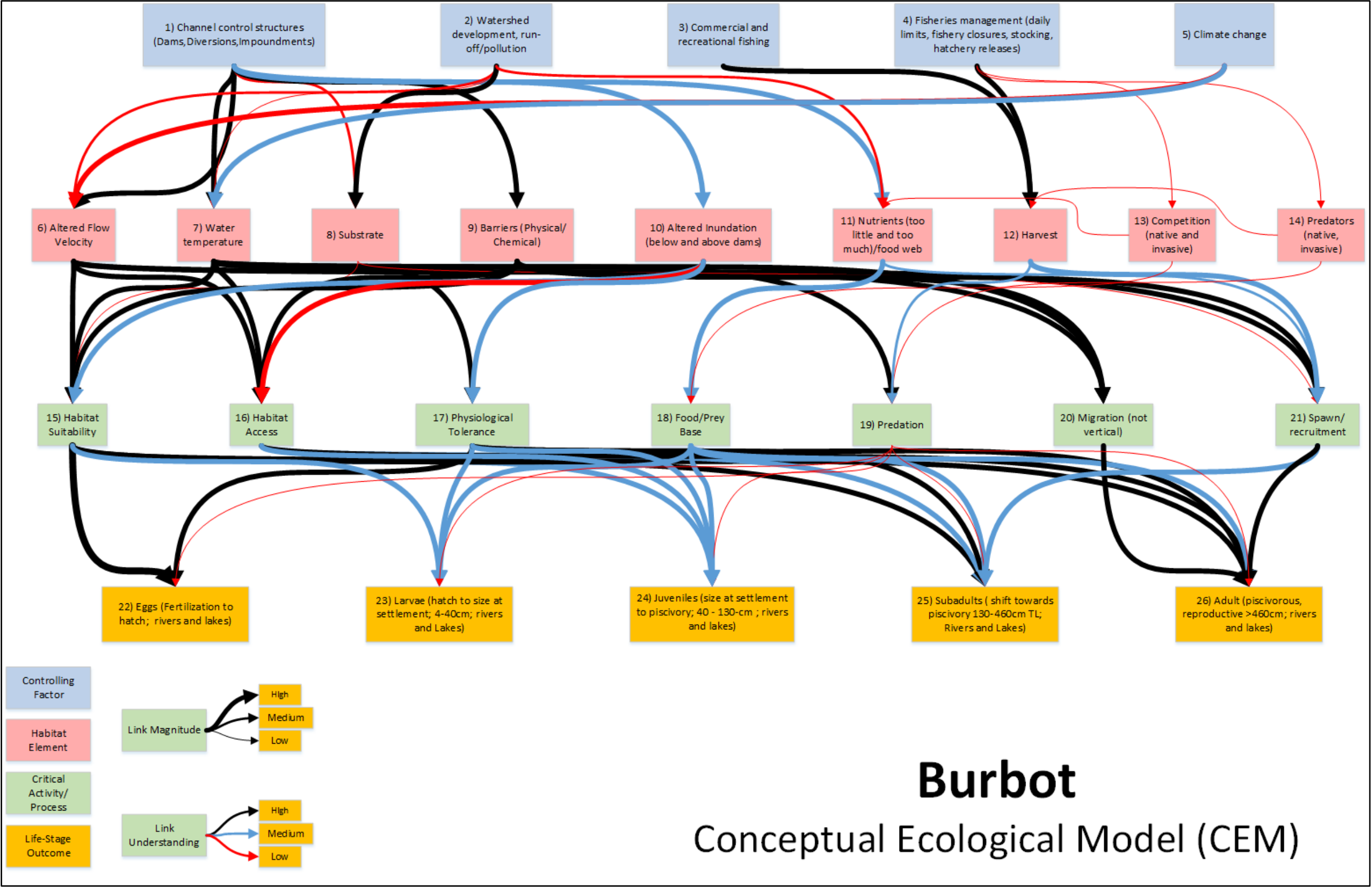


Figure 2-12. General Conceptual Ecological Model for Burbot.

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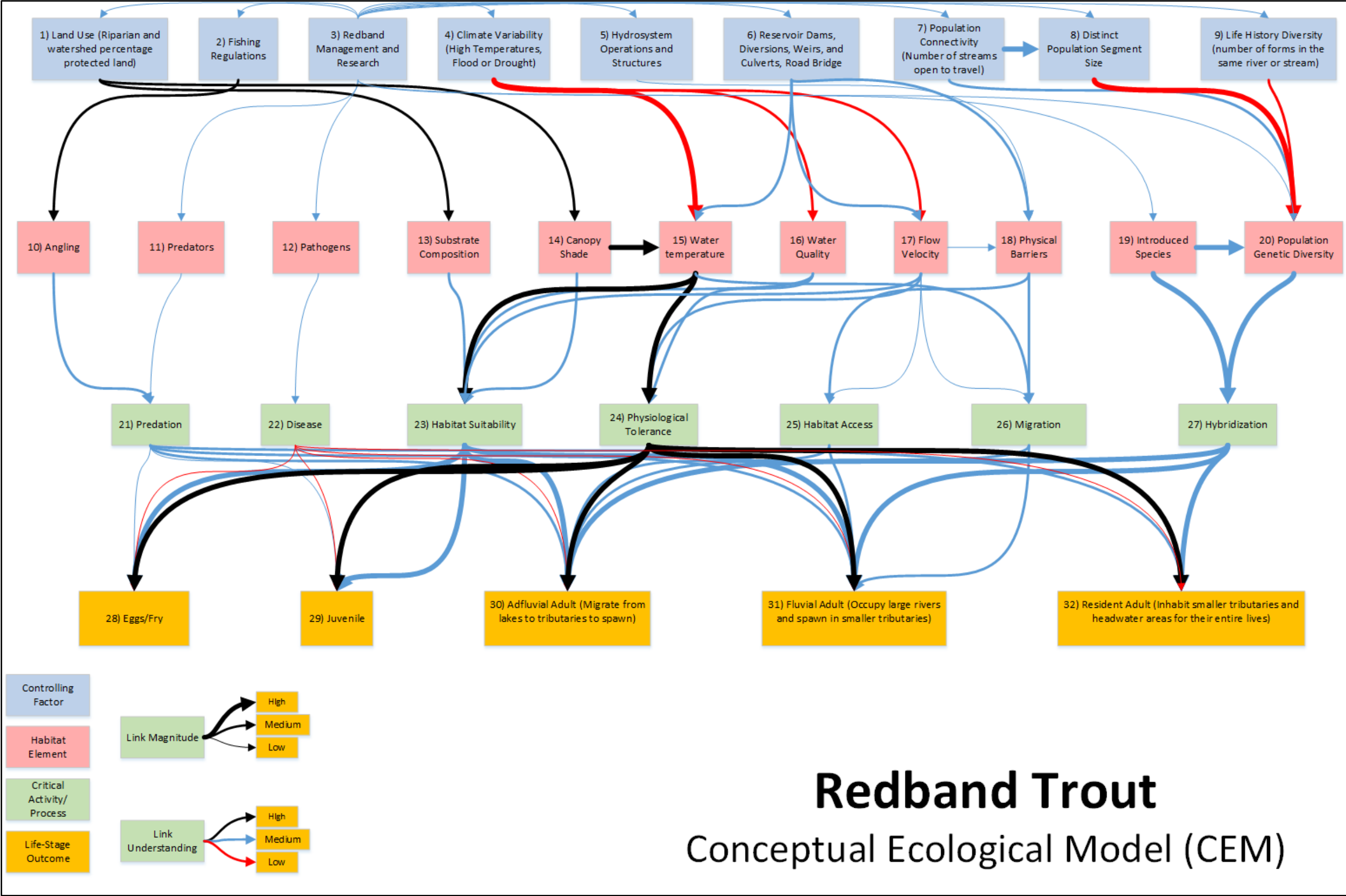


Figure 2-13. General Conceptual Ecological Model for Redband Trout.

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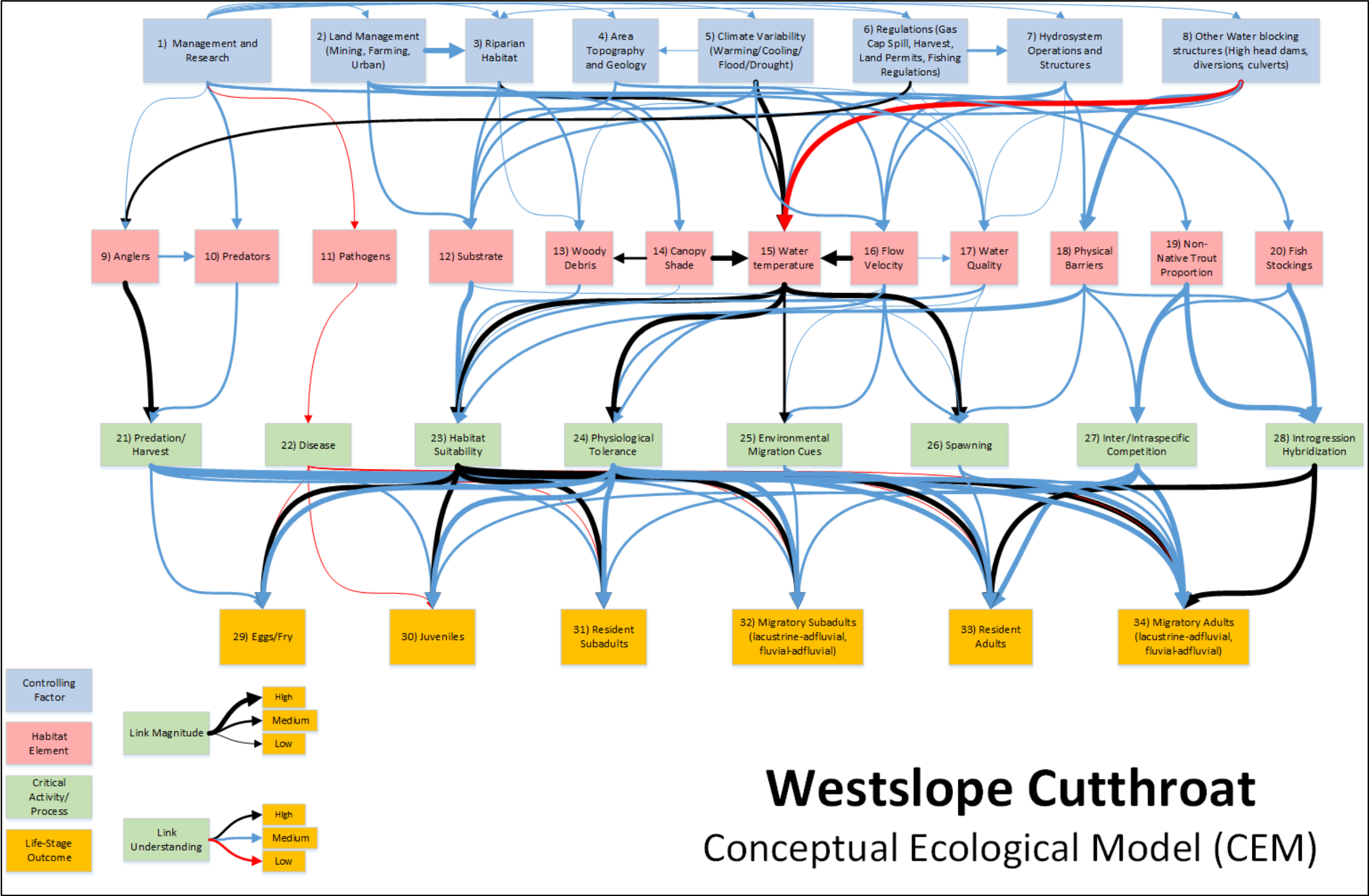


Figure 2-14. General Conceptual Ecological Model for Westslope Cutthroat Trout.

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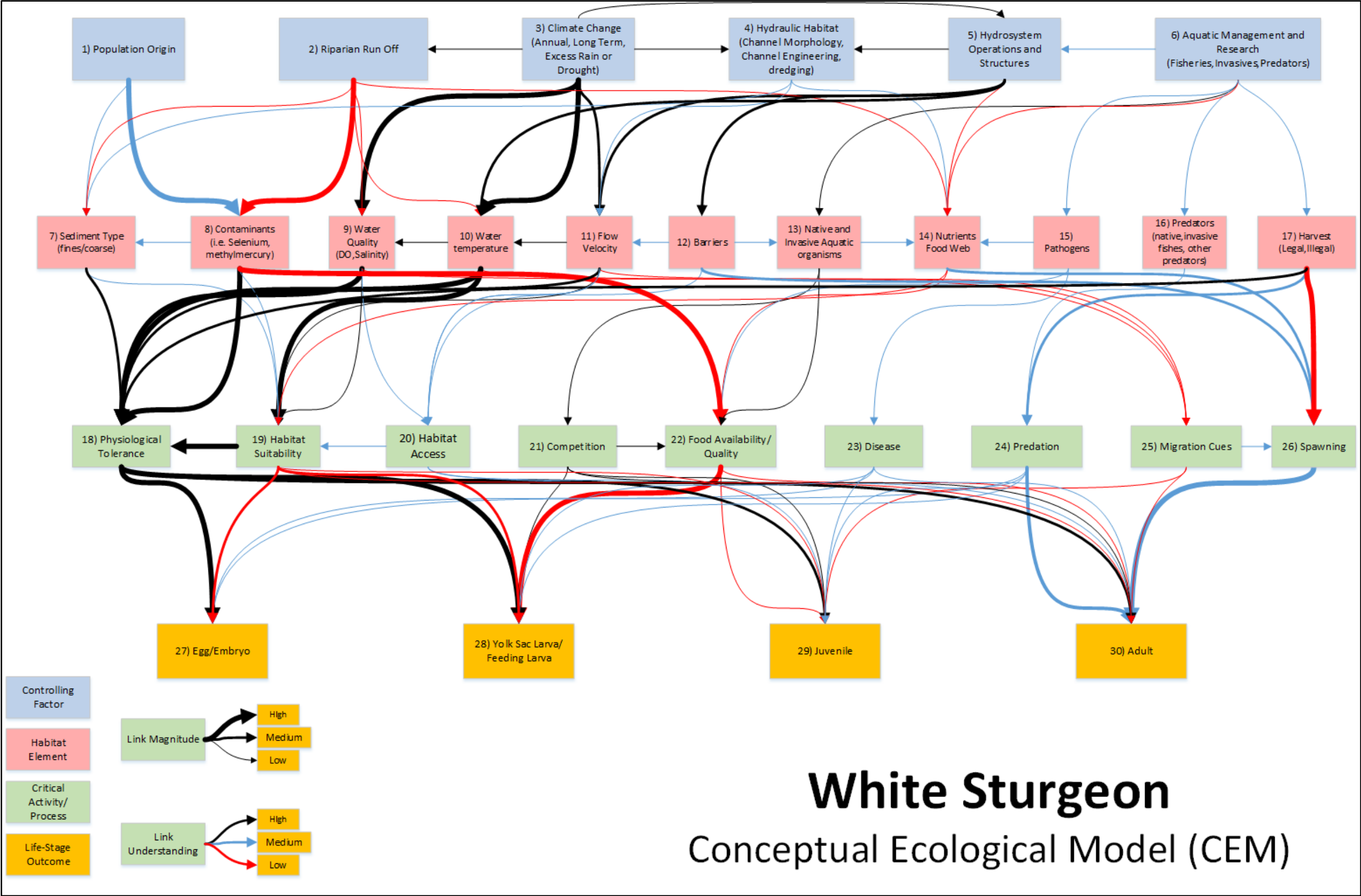


Figure 2-15. General Conceptual Ecological Model for White Sturgeon.

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2.17 QUALITATIVE ANALYSES

CEMs illustrate the relationships between controlling factors (drivers), environmental factors, critical processes, and life history requirements at the species level. In this EIS, many species or communities were analyzed using the relationships in the CEMs to inform qualitative analyses that was done in a combination of individual (by fish team members) and workshop settings using matrices to document analyses. Some species, such as Pacific eulachon, green sturgeon, lamprey, etc. was done at that species level. Other species were analyzed on a more regional or local scale, such as sockeye salmon that were analyzed in different workgroups for Upper Columbia sockeye salmon and Snake River sockeye salmon, for example. Still others, as in the case of resident fish, were analyzed in workgroups organized by regions and fish were considered at the fish community level to understand how they interact with one another and the environmental factors. Some key species were documented on a dedicated matrix in these communities and others were lumped into groups such as “gamefish” or “native fish” for analysis documentation. Finally, white sturgeon are understood to exhibit both anadromous and resident behaviors; they are discussed and documented under resident fish in the different regions in this EIS, but in Region D (below McNary Dam) they were analyzed in the same workgroup as lower river anadromous species such as green sturgeon and Pacific eulachon.

As mentioned, qualitative analyses was guided and documented using a matrix. A sample of the matrix columns are shown, for illustrative purposes, for analyzing the effects of just one parameter. In this example, as many rows as necessary were populated with important relationships between environmental factors and the fish life history stages. This relationship and criteria (if known) are documented in the first column and the second column is for the metric that was used to measure the change to that relationship. The fish team used outputs, either numerical or qualitative, from the Hydrology and Hydraulics, Water Quality, Sediment, and other teams as appropriate to determine the effects on the fish resource under evaluation. The output for the No Action Alternative would be captured as shown, and the group discussed what the effects of No Action are, based upon model outputs and current knowledge informing what would be expected if the NAA operations and configurations continued into the future. Notes that did not necessarily describe the effect but informed the discussion were captured in the notes column. The data for the same parameter for an alternative, again from hydrology or water quality modeling, or in some cases qualitative outputs, for the Alternative under consideration was documented and the team then discussed the effects of that change and information was documented in the same manner.

Table 2-1. Sample Matrix Analysis Table.

Relationship/Criteria	Metric	NAA Data	NAA Effects	NAA Notes	Alt 0 Data	Alt 0 Effects	Alt 0 Notes
Higher flows in May result in further upstream movements of species X, which increases spawning success.	May mean monthly flows at McNary Dam	205kcfs	Current level of spawning success would continue	Monitoring results show good success.	195kcfs (5kcfs lower)	Adverse effect due to decreased May flows	Spawning success known to drop x% in years with less than 200kcfs flows.

In this hypothetical and simplified example, it was established that higher flows increases spawning success, and the best metric to measure that is the mean monthly flow in May at McNary Dam; spawning is successful under the NAA, but the Alternative 0 would reduce average flows in May by 10kcfs and this would be expected to reduce spawning success. This example shows just one relationship; several key relationships and their relative importance were developed and discussed, as needed, to complete a thorough analysis of the fish resource. For each alternative, columns were added to the matrix and the same process followed.

Typically the description of the resources (Affected Environment), the important relationships/criteria and metrics, and the effects of the NAA were developed in one workshop, and subsequent workshops and followup work was completed as data became available for each of the four Multi-Objective alternatives (MO1, MO2, MO3, MO4). The workshops were led by fish team leads or subbasin leads for some resident fish sections, and teams were formed by self-selection based on interest and expertise. For example, a workgroup would typically include a team lead, co-lead agency members with expertise in that particular species or area, and cooperating agency members with expertise, interest, or managing authority. The team lead prepared and organized information, such as data and other resources, for the workshops and teams worked together to complete the analyses. Additionally, in some cases as the group worked through the analyses of alternatives they would identify additional resources or information that would strengthen it and this further work was completed either individually by a fish team lead or member or small groups and brought back to the team for further discussion. Species-specific or region-specific methods that were developed through the process are further described either in the matrices or introductory information in the Data/Results section of this appendix. Teams were generally able to come to agreement on effects, but if there were dissenting opinions these were captured in the matrix. After the workshops, the work team was given an opportunity to review the matrices, then they were used to draft the effects analyses sections in Chapter 3.5.

CHAPTER 3 - DATA AND RESULTS

3.1 UPPER COLUMBIA RIVER SALMON AND STEELHEAD

3.1.1 Upper Columbia Spring-Run Chinook Salmon

3.1.1.1 COMPASS Results

Table 3-1. Summary results for Upper Columbia River spring Chinook by Alternative.

Alternative	Mean Survival (RIS to BON)	Mean Survival (MCN to BON)	SD survival (year-to-year)	Mean Arrival at BON	Proportion Destined for Transport	Mean Gas Exposure	Proportion Powerhouse Passage	Mean Traveltime (RIS-MCN) (Days)	Mean Traveltime (MCN-BON) (Days)	Mean Migration Rate (RIS-MCN) (mi/day)	Mean Migration Rate (MCN-BON) (mi/day)	Mean Temp Experience (RIS-Hanford)	Mean Temp Experience (Lower Columbia)	Mean Flow Experience (RIS-Hanford)	Mean Flow Experience (Lower Columbia)	Mean Gas Experience (RIS-Hanford)	Mean Gas Experience (Lower Columbia)	Avg. Num Bypasses	Avg. Num Turbine Passages	Avg. Num Spill Passages
NAA	0.5007	0.6947	0.03233	147.76	0.00	0.5007	0.471	14.52	6.05	13.48	29.62	12.16	15.02	164.07	293.22	103.35	115.83	1.11	2.18	3.71
MO1	0.5038	0.7000	0.03436	147.79	0.00	111.40	0.440	14.75	5.79	13.29	30.07	12.19	15.05	159.26	288.18	102.97	115.84	0.97	2.11	3.92
MO2	0.4956	0.6868	0.03718	148.12	0.00	104.44	0.523	14.58	6.33	13.68	30.47	12.13	15.06	161.66	291.81	100.77	105.73	0.73	2.93	3.34
MO3	0.5087	0.7061	0.03444	147.37	0.00	103.19	0.413	14.75	5.39	13.52	33.01	12.13	14.96	158.85	286.53	100.80	102.76	0.81	2.09	4.11
MO4	0.5117	0.7101	0.03045	147.12	0.00	112.69	0.362	14.55	5.29	13.44	31.95	12.16	14.96	163.74	291.32	102.14	119.05	0.71	1.82	4.47

3.1.1.2 TDG Tool Results

Table 3-2. Mean survival, Reach Average Exposure (RAE), and number of days (80 year) when RAE is greater or equal to 120% TDG for Upper Columbia River juvenile Spring Chinook from MCN – BON

Alternative	Survival (%)	RAE TDG %	No. Years RAE >= 120%
NAA_UC	97.7	115.9	4
MO1_UC	97.8	116	3
MO2_UC	98.8	113	2
MO3_UC	97.6	116.7	3
MO4_UC	95.8	119.3	27

3.1.1.3 Life Cycle Model Results

Northwest Fisheries Science Center (NWFSC) Life Cycle Modeling (LCM) uses COMPASS inputs to produce estimates of adult return metrics for one population (Wenatchee) of Upper Columbia Spring Chinook salmon. This information was used as an indicator to compare the adult returns of the Upper Columbia Spring-Run Chinook salmon ESU across the alternatives.

Table 3-3. NWFSC Life Cycle Model Upper Columbia River Spring-Run Chinook Salmon SAR (Rock Island to Bonneville) Results.

Alternative	Juvenile Survival	SAR
NAA	0.501	0.0094
MO1	0.504	0.0095
MO2	0.491	0.0093
MO3	0.504	0.0095
MO4	0.512	0.0096

Table 3-4. Quantiles of the Geometric Mean Abundance (across all years) for Wenatchee River Spring-Run Chinook Salmon.

Alternative	2.5 Quantile	25 Quantile	50 Quantile	75 Quantile	97.5 Quantile
NAA	161	323	498	733	1641
MO1	166	345	526	812	1622
MO1 + 10% LM	189	378	570	870	1677
MO1 + 25% LM	209	465	690	1043	2023
MO1 + 50% LM	276	557	822	1228	2415
MO1 + 100% LM	690	1562	2174	2986	4978
MO2	152	321	482	723	1546
MO3	153	328	519	781	1593
MO3 + 10% LM	189	405	636	957	1844
MO3 + 25% LM	230	576	882	1278	2483
MO3 + 50% LM	371	816	1228	1749	3298
MO3 + 100% LM	1685	3134	4245	5570	8768
MO4	170	347	513	785	1599

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Alternative	2.5 Quantile	25 Quantile	50 Quantile	75 Quantile	97.5 Quantile
MO4 + 10% LM	195	441	673	990	1886
MO4 + 25% LM	260	582	901	1306	2442
MO4 + 50% LM	420	897	1308	1829	3269
MO4 + 100% LM	1804	3285	4422	5715	8664

3.2 UPPER COLUMBIA RIVER STEELHEAD

3.2.1 COMPASS Results

Table 3-5. Summary results for Upper Columbia River Steelhead by Alternative

Alternative	Mean Survival (RIS to BON)	Mean Survival (MCN to BON)	SD survival (year-to-year)	Mean Arrival at BON	Proportion Destined for Transport	Mean Gas Exposure	Proportion Powerhouse Passage	Mean Traveltime (RIS-MCN) (Days)	Mean Traveltime (MCN-BON) (Days)	Mean Migration Rate (RIS-MCN) (mi/day)	Mean Migration Rate (MCN-BON) (mi/day)	Mean Temp Experience (RIS-Hanford)	Mean Temp Experience (Lower Columbia)	Mean Flow Experience (RIS-Hanford)	Mean Flow Experience (Lower Columbia)	Mean Gas Experience (RIS-Hanford)	Mean Gas Experience (Lower Columbia)	Avg. Num Bypasses	Avg. Num Turbine Passages	Avg. Num Spill Passages
NAA	0.4782	0.6575	0.03473	147.65	0.00	111.63	0.389	7.79	6.63	29.98	25.09	12.46	14.89	168.00	299.03	103.29	115.90	1.12	1.60	4.28
MO1	0.4748	0.6559	0.03781	147.91	0.00	111.46	0.370	8.14	6.66	29.38	24.96	12.47	14.95	163.09	294.78	102.89	115.91	1.03	1.56	4.41
MO2	0.4660	0.6395	0.03775	147.53	0.00	104.34	0.413	7.86	6.44	31.33	26.50	12.42	14.87	165.40	296.73	100.54	105.88	0.83	2.06	4.11
MO3	0.4808	0.6621	0.03775	147.62	0.00	103.03	0.360	8.08	6.46	30.83	26.60	12.41	14.84	162.55	293.49	100.61	102.64	0.96	1.56	4.48
MO4	0.4817	0.6610	0.03165	147.54	0.00	112.78	0.331	7.65	6.63	30.12	25.09	12.45	14.89	168.40	298.18	102.07	119.21	0.88	1.43	4.69

3.2.2 TDG Tool Results

Table 3-6. Mean Reach Average Exposure (RAE) results for Upper Columbia River juvenile Steelhead in Lower Columbia reach (MCN – BON)

Alternative	RAE (%)
NAA_UC	116
MO1_UC	116.1
MO2_UC	113.1
MO3_UC	117
MO4_UC	119.6

Table 3-7. Mean survival results for Upper Columbia River juvenile Steelhead in Lower Columbia reach (MCN – BON)

Alternative	Survival (%)
NAA_UC	96.9
MO1_UC	96.9
MO2_UC	98.1
MO3_UC	96.3
MO4_UC	93.9

Table 3-8. Counts of years when Reach Average Exposure (RAE) is greater than, or equal to 120% for juvenile Upper Columbia Steelhead in Lower Columbia reach (MCN – BON)

Alternative	Counts of years when RAE is >= 120% for Lower Columbia (MCN-BON)
NAA_UC	5
MO1_UC	4
MO2_UC	2
MO3_UC	3
MO4_UC	34

3.3 UPPER COLUMBIA RIVER COHO SALMON

Table 3-9. Upper Columbia River Coho Salmon Qualitative Effects Analysis Matrix

Affected Environment Important Relationships/Criteria	Affected Environment Metric	Effects to Resource NAA	Effects to Resource MO1	Effects to Resource MO2	Effects to Resource MO3	Effects to Resource MO4	Notes
Juvenile passage at the four lower Columbia River dams affects in-river survival rate (MCN to BON) of juvenile coho salmon returning to the upper Columbia River (upstream of MCN).	Juvenile upper Columbia River spring Chinook salmon as surrogate for juvenile coho response for this metric. Reference survival for upper Columbia coho (UC/Yakima) No Action Alternative. Estimate change in in-river survival (e.g., MO1-NAA/NAA) for juvenile Snake River spring Chinook as surrogate for coho using COMPASS and CSS in-river survival estimates. ¹	2007-2017 MCN to BON average upper Columbia River coho in-river survival (95% lower and upper confidence intervals) from Widener et al. (2018), Table 33: 86% (75% to 96%)	See change in upper Columbia River spring Chinook salmon downstream passage.	See change in upper Columbia River spring Chinook salmon downstream passage.	See change in upper Columbia River spring Chinook salmon downstream passage.	See change in upper Columbia River spring Chinook salmon downstream passage.	Widener et al. (2018), Table 33, for in-river survival estimate for UC/Yakima coho. Re-grouping to combine cohorts for this EIS was performed by Dan Widener in 2019 for purposes of NAA estimate of in-river survival. Another citation from previous year annual report: Faulkner, James R., Daniel L. Widener, Steven G. Smith, Tiffani M. Marsh, and Richard W. Zabel. NOAA, April 2017, Appendix B9-10.
Predation in reservoirs – changes in the LGR to BON reservoir environments (relative to the NAA) may change the susceptibility of Snake River juvenile coho salmon to avian and piscine predators.	Susceptibility of juvenile coho to predators (avian and piscine) in reservoirs. The fish team will also evaluate measures that affect the predation rate. Change in piscine predator activity is captured at least in part by COMPASS in-river survival response (juvenile upper Columbia spring Chinook) above and does not need duplication or double counting. Metrics: 1) Change in proportion turbine passage (an increase may signify higher susceptibility to predation); 2) Improved fish passage (IFP) turbines (this measure should pass fish with less impact than non-IFP turbines); and 3) Change in travel time (an increase may signify higher susceptibility to predation).	1) 0.82 average turbine passages for upper Columbia River spring Chinook salmon from Rock Island to BON (COMPASS). 2) IFP turbines at IHR and MCN, not JDA. 3) Travel time 6.1 days juvenile upper Columbia Chinook salmon average travel time from MCN to BON (COMPASS). CSS estimates only for LGR to BON travel time and powerhouse passages (bypass, turbine, ITS routes combined).	1) and 3) See change in upper Columbia River spring Chinook downstream passage. 2) IFP turbines from NAA, also JDA.	1) and 3) See change in upper Columbia River spring Chinook downstream passage. 2) IFP turbines from NAA, also JDA.	1) and 3) See change in upper Columbia River spring Chinook downstream passage. 2) IFP turbines from NAA, also JDA.	1) and 3) See change in upper Columbia River spring Chinook downstream passage. 2) IFP turbines from NAA, also JDA.	Tiffan and Connor (2018) for piscine predators; BPA project reports – pikeminnow sport reward and USGS reports OSU and RealTime Research reports for avian predation Collins et al., 1998 Ward, 1996
Adult upstream passage at the four lower Columbia River dams affects in-river survival rate of adult upper Columbia River coho salmon.	Use adult upper Columbia River fall Chinook salmon passage analysis as proxy for adult coho passage considerations. ²	Adult survival estimate BON to MCN for upper Columbia River coho or upper Columbia River fall Chinook salmon.	See change in fall Chinook salmon upstream passage for MO1.	See change in fall Chinook salmon upstream passage for MO2.	See change in fall Chinook salmon upstream passage for MO3.	See change in fall Chinook salmon upstream passage for MO4.	CP: For fall Chinook there are two Jeff Fryer projects – tribes tag juvenile fall Chinook at Vernita Bar (would need to ask for upstream survival), and project 200851800 also tags fall Chinook salmon.

¹Coho-specific dam survival measurements are not available, but coho-specific in-river survival estimates are available for current system conditions. There are no coho-specific models available to predict changes in these metrics from CRS alternatives. However, survival models that project changes in these metrics based on changes in hydrosystem operation and configurations are available for spring Chinook salmon and steelhead (COMPASS, CSS). Coho salmon outmigration timing generally overlaps with both spring Chinook salmon and steelhead, and all three species have dominant stream-type life histories. However, the size of juvenile coho and juvenile spring Chinook salmon tend to be more closely aligned than juvenile steelhead. Therefore, juvenile spring Chinook salmon

will be considered the appropriate surrogate for juvenile coho salmon for purposes of qualitative effects analysis of changes in passage. This use of juvenile Snake River spring Chinook salmon as a surrogate for juvenile lower Columbia River coho salmon is consistent with the 2008 FCRSP BiOp, 2013 Recovery Plan, and 2019 CRS BiOp.

²Dam survival and reach survival measurements specific to adult coho are not available for the previous 10-year period. Adult Coho salmon upstream migration timing general overlaps with fall Chinook salmon, through fall Chinook salmon migration timing tends to start earlier in some years (DART). Far more adult fall Chinook salmon enter the CRS system than Coho salmon adults, so survival estimates generally have higher certainty for the former than the latter. Adult fall Chinook salmon will be considered the appropriate surrogate for adult coho salmon for purpose of qualitative effects analysis of changes in passage. This use of adult Snake River fall Chinook salmon as a surrogate for adult lower Columbia River coho salmon is consistent with the 2008 FCRPS BiOp, 2013 Recovery Plan, and 2019 CRS BiOp.

NOTE ABOUT OCEAN SURVIVAL: The CSS (2017) makes no prediction in terms of survival benefits for lower Columbia River, upper Columbia River, or lower Snake River coho salmon. The CSS predicts that increased spill could substantially reduce latent mortality of juvenile yearling Chinook salmon and steelhead moving downstream through the mainstem dams. If this were to occur for coho salmon, SARs would also be improved for the XX populations that pass above XX dams and migrate during the spring, and the potential benefit would generally be less than what may occur for species that experience passage through a greater number of Columbia and Snake River mainstem dams (NMFS, 2019).

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3.4 UPPER COLUMBIA RIVER SOCKEYE SALMON

Table 3-10. Columbia River Sockeye Salmon Qualitative Effects Analysis Matrix

Affected Environment Important Relationships/Criteria	Affected Environment Metric	Effects to Resource NAA	Effects to Resource MO1	Effects to Resource MO2	Effects to Resource MO3	Effects to Resource MO4	Notes
Juvenile Mainstem Passage							
Juvenile travel time corresponds with juvenile survival.	Downstream travel time (PRD to BON): Surrogates Chinook. Survival of surrogates	Travel Time = 20.56 Days Juvenile fish will survive at similar rates under the NAA.	Travel time = 20.54 Days No change from NAA	Travel time = 20.91 Days - 8 hours longer. Negligible change from NAA	Travel time = 20.14 Days - 10 hours shorter. Negligible change from NAA	Travel time = 19.84 days is 3.0% shorter than NAA (~ 17 hours shorter) Minor decrease from NAA should lead to minor increases in survival	Flow Augmentation water may be more effective in low water years.
Transport as juveniles results in more fallback and longer migration time, and more straying during upstream adult migration (Crozier et al., 2018). This relationship is much weaker for Upper Columbia River sockeye.	Percent of juvenile sockeye transported, fallback rates.	No transportation of CR sockeye now. The component of fallback attributed to sockeye is not an issue in the NAA.	No transportation of CR sockeye now. No change from the NAA.	Transport potential at MCN. Transportation at MCN would increase juvenile survival and decrease adult delay. Look at MCN transport data for Sockeye. May use a different collection system.	No transportation of CR sockeye now. No change from the NAA.	No transportation of CR sockeye now. No change from the NAA.	Straying, not shown a correlation with transport, but assume more fallback causes more straying. Few PIT tags in juvenile CR sockeye, so difficult to monitor. Fallback relationship to transport is much weaker in UC Sockeye. Transported fish have higher juvenile survival.
Flows can affect downstream juvenile migration rates.	Low Flow (75th percentile?) at MCN from Apr 15 - Jun 15. Migration Rate May want to look at bracketing the major portion of the migration.	75% Flow at MCN (Apr 15 - Jun 15) is 208,432 cfs. Mean Travel time is 20.57 days RIS to BON. Use Migration rate alone? Under the NAA sockeye would continue migrate at the current rates.	75% flow at MCN (Apr 15 to Jun 15) is 203,038 cfs Under driest 25% of years MO1 has slightly lower flows during outmigration. Mean TT is 20.54 days RIS to BON (No change).	75% flow at MCN (Apr 15 to Jun 15) is 204,824 cfs Under driest 25% of years MO2 has slightly lower flows during outmigration than NAA. Mean TT is 20.91 days RIS to BON (No change).	75% flow at MCN (Apr 15 to Jun 15) is 202,827 cfs Under driest 25% of years MO3 has the lowest flows during migration. Mean TT is 20.14 days RIS to BON (No change).	75% flow at MCN (Apr 15 to Jun 15) is 208,944 cfs. Under driest 25% of years MO4 has the highest flow during migration. Mean TT is 19.84 days RIS to BON (fastest). Under low flow years expect to see larger difference from NAA.	Dates specific to Rock Island tagged fish - encounters at McNary. Wenatchee fish arrive earlier than Okanagan fish, but not a strong relationship. Low Flow years more critical - review 25th percentile for differences. There does not appear to be a correlation between mean flow at MCN from mid Apr to mid Jun and migration rate. Why does migration in PUDs take so much longer than MCN to BON?
Predation in reservoirs – changes in the reservoir environment (relative to the NAA) may change the susceptibility of juvenile sockeye to avian and piscine predators.	Risk of predation to piscine predators. Use temperature during outmigration (Apr 15 - May 31 at MCN) as a surrogate for piscine predation. Use habitat increase or decrease for avian predators (See below)	Mean Water temperature April 15 - May under NAA is 12.03C degrees (SD 2.17). Under the NAA an unknown number of juvenile sockeye will be removed from the population by piscine predators. Literature estimates that smallmouth bass, Walleye, and NPM	Mean Water temperature April 15 - May under NAA is 12.06C degrees (SD 2.15). No change from NAA	Mean Water temperature April 15 - May under NAA is 12.05C degrees (SD 2.13). No change from NAA.	Mean Water temperature April 15 - May under NAA is 12.05C degrees (SD 2.12). Under MO3 piscine predator numbers may be reduced or experience significant habitat alterations because of high sediment and low dissolved oxygen concentrations during	Mean Water temperature April 15 - May under NAA is 12.05C degrees (SD 2.12). No change from NAA.	Generally, temp results on predation are not expected to affect sockeye. Oregon looks at predation in terms of abundance x rate of predation. If measure is likely to change either abundance or rate, then assume changing. Then compensatory or additive. No abundance data. Note: change in piscine predator activity is captured at least in part by COMPASS (juvenile Chinook) via the temperature relationship.

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Affected Environment Important Relationships/Criteria	Affected Environment Metric	Effects to Resource NAA	Effects to Resource MO1	Effects to Resource MO2	Effects to Resource MO3	Effects to Resource MO4	Notes
		remove large numbers of smolts. Erhardt et al. (2018) and Tiffen et al. (2018) found that SMB consumed over 300,000 sub adult chinook in a 22 km study reach. MCN pool is a predator refuge.			dam breaching on the Lower Snake River. The team expects displacement of some predators below the confluence for a short time. Overall there will be a decrease in risk to piscine predation at the time of breaching followed by gradual increases in risk.		
Avian predation – avian nesting habitat increases or decreases	Increase or decrease in avian nesting habitat.	Mean Water temperature April 15 - May under NAA is 12.03°C degrees (SD 2.17). Under the NAA, an unknown number of juvenile sockeye will be removed from the population by piscine predators. Literature estimates that smallmouth bass, Walleye, and northern pikeminnow remove large numbers of smolts. Erhardt et al. (2018) and Tiffen et al. (2018) found that smallmouth bass consumed over 300,000 sub adult Chinook in a 22-km study reach. MCN pool is a predator refuge.	Mean Water temperature April 15 - May under NAA is 12.06°C degrees (SD 2.15). No change from NAA	Mean Water temperature April 15 - May under NAA is 12.05°C degrees (SD 2.13). No change from NAA.	Mean Water temperature April 15 - May under NAA is 12.05°C degrees (SD 2.12). Under MO3, piscine predator numbers may be reduced or experience significant habitat alterations because of high sediment and low dissolved oxygen concentrations during dam breaching on the lower Snake River. The team expects displacement of some predators below the confluence for a short time. Overall there will be a decrease in risk to piscine predation at the time of breaching followed by gradual increases in risk.	Mean Water temperature April 15 - May under NAA is 12.0°5C degrees (SD 2.12). No change from NAA.	18°C is inflection point for survival/temp relationship. This relationship is not as strong for Upper Columbia Sockeye because they typically migrate 5 to 7 days earlier than Snake River Sockeye. Okanagan sockeye arrive when temps are > 21° C and hold in the mainstem. Fish hold in mainstem until they get a temperature break in the Okanagan and move up. Earlier runs do best. Cumulative stress of moving up through warm water in Columbia, then warm at confluence of Okanagan decreases survival and gamete viability.
Spill affects juvenile migration routes through the projects. Increased spill = faster travel time, beneficial to juveniles; potentially higher fallback and delays at BON. More spill = fewer powerhouse encounters? See Snake River sockeye metric for question on this one.	Surrogate in-river survival and SARs Chinook as surrogate Look at low flow years in separate analysis.	Average 50.1% in-river survival for juvenile Chinook Under the NAA sockeye survival is not expected to change.	Average 50.4% in river survival No change from NAA	Average 50.0% in river survival No change from NAA	Average 50.9% in river survival Minor increase in survival from NAA Turbidity levels may help survival of smolts Additional smolts from Snake River may also help with predator swamping.	Average 51.2% in river survival Minor increase in survival from NAA	Not much research done on Columbia River sockeye, use Snake River relationships. When do sockeye pass (Columbia River fish peak around 7pm and Snake River sockeye peak in afternoon). See CSS and Faulkner estimates for Snake River sockeye in-river survival and SARs. Potentially PITPH if available. Look at variability in flow years. Low flows may be more important than other years.

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Affected Environment Important Relationships/Criteria	Affected Environment Metric	Effects to Resource NAA	Effects to Resource MO1	Effects to Resource MO2	Effects to Resource MO3	Effects to Resource MO4	Notes
Adult Mainstem Passage							
Higher water temperatures correspond to lower adult survival (less than 50% when water temperature is greater than 18°C). When Okanagan River gets to 21°C to 22°C, fish stop moving into Okanagan River. Survival then depends on temperatures in the Columbia River for survival.	Percent of total days mean temperature exceeds 18C at MCN and CHJ Jun through Aug Check variability of temperatures - MO3 fluctuations. July 1 - August.	MCN = 72.4% CHJ = 24.9% Temperatures would exceed 18°C at MCN dam (Jun-AUG) ~ 72% of the time and at CHJ dam 25% of the time. Some years, temperature will continue to have negative impacts to the species. Should expect 50% survival or less on hot years.	MCN = 73.0% CHJ = 25.7% No Difference from NAA	MCN = 73.0% CHJ = 26.6% Negligible increase of ~ 2 days over 18°C at CHJ MCN no change from NAA	MCN = 73.7% CHJ = 25.6% No change from NAA	MCN = 73.0% CHJ = 35.0% Minor increase - 10% increase in days over 18°C at CHJ - No Difference from NAA at MCN MCN augmentation water would run out in dry years and leave less water for later in the summer = more hot days and a decrease in Upper Columbia survival	18°C is inflection point for survival/temp relationship. This relationship is not as strong for Upper Columbia sockeye because they typically migrate 5 to 7 days earlier than Snake River sockeye. Okanagan sockeye arrive when temps are > 21° C and hold in the mainstem. Fish hold in mainstem until they get a temperature break in Okanagan and move up. Earlier runs do best. Cumulative stress of moving up through warm water in Columbia, then warm at confluence of Okanagan decreases survival and gamete viability.
Hydrosystem delays (operations and natural) result in migration period where unregulated corridor temperatures have become too warm. May need better or different metric to capture delay effects.	Arrival timing at PRD Mean Temp Jun 15 to Jul 31 and percent of Days over 18°C	On average temps reach 18°C at PRD on July 1. On this date, 74.4% of the run still remains. Mean temp Jun15-Jul31 = 18.06°C; % of days over 18°C = 52.4 A proportion of the run (74.4 %) would reach PRD after the river reaches 18C. This proportion of sockeye run may experience delays due to the arrival timing/warm temperatures correlation.	On average temps reach 18°C at PRD on July 1. On this date, 74.4% of the run still remains in river. No difference from NAA Mean temp Jun15-Jul31 = 18.04°C; % of days over 18°C = 48.7 ~ 1.5 days less. Slight reduction in heat induced stress under MO1 compared with NAA.	On average temps reach 18°C at PRD on June 30. On this date, 79.2% of the run still remains in river. No difference from NAA Mean temp Jun15-Jul31 = 18.05°C; % of days over 18°C = 48.8 ~ 1.5 days less. Slight reduction in heat induced stress under MO1 compared with NAA.	On average temps reach 18°C at PRD on June 30. On this date, 79.2% of the run still remains in river. No difference from NAA Mean temp Jun15-Jul31 = 18.10°C; % of days over 18°C = 49.5 ~ 1 days less. Slight reduction in heat induced stress under MO1 compared with NAA.	On average temps reach 18°C at PRD on June 30. On this date, 79.2% of the run still remains in river. No difference from NAA Mean temp Jun15-Jul31 = 18.23°C; % of days over 18°C = 49.8 ~ 1 days less. Slight reduction in heat induced stress under MO1 compared with NAA.	Can the team develop a relationship between temperature and arrival timing? Snake River Sockeye have different arrival timing but same temperature relationships. See Jeff Fryer reports. Arrivals early and late tend to do poorer than those in the middle of the run. Wenatchee run is earlier than Okanagan, but PIT shows Okanagan fish early and late, bigger run too. Could also be adapting to better conditions. Optimum temp/flows for fastest migration - Very low and hot = slow, low flow can lead to faster reservoir passage. This metric does not distinguish between the alternatives - Recommend deletion.
Temperatures cause migration delays where sockeyes are more susceptible to harvest (in harvest area for more time). More delay – later arrival and more likely to encounter war tributaries. Forced to hold in mainstem areas with anglers.	Temperature, compare alternative temp to NAA. Temp in Okanagan River relates to Wells pool staging. Okanagan River sockeye stage until temperatures drop in Okanagan River. Any alternative that changes the temperature would change risk of harvest for these fish. Do any of the alternatives have potential to change migration timing?	–	Temperature, compare alternative temp to NAA. Temp in Okanagan River relates to Wells pool staging. Okanagan River sockeye stage until temperatures drop in Okanagan River. Any alternative that changes the temperature would change risk of harvest for these fish. Do any of the alternatives have potential to change migration timing?	–	–	–	Temperatures in Wells pool and Okanagan river affect how long fish stage at the mouth where they are susceptible to harvest. Adults use Wells pool as thermal refugia until tributary temps cool and are conducive to survival. Delay is a function of tributary temperature and is generally unaffected by CRSO. Sockeye harvest is targeted to Mid-Columbia stocks. If Snake River stock is delayed they get into the harvest. Snake River harvest explicitly capped at 5% to 7% and Upper Columbia sockeye harvest kept at that level in fisheries on mixed stocks, so susceptibility to harvest may not change with temperature. Wells pool, if no temp barrier there is limited harvest. May also have higher temp tolerance, and shorter migration.

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Affected Environment Important Relationships/Criteria	Affected Environment Metric	Effects to Resource NAA	Effects to Resource MO1	Effects to Resource MO2	Effects to Resource MO3	Effects to Resource MO4	Notes
Is the proportion of sockeye using navigation locks rather than fish ladders related to total migration survival, and does flow or temp influence use navigation lock? Crozier et al. (2016) shows detection efficiencies of between 88% and 98%. Likely a surrogate for NavLock passage ~ 1% at most.	If navigation lock use is a function of flow or temp, those are the metrics.	Output: Analyze ladder counts to estimate proportion of run using navigation locks, then compare with annual temp/flow data Ladder count at MCN and PRD ~ if PRD ladder count is higher than Nav lock fish must make difference. Effects: Proportions using NavLock and total adult survival do not change under the NAA.	–	–	–	–	Sockeye are known to migrate through navigation locks in significant numbers but proportion of the run using them, mechanisms influencing use, and effect on migration survival may not be known. Talk with Derek Fryer. Crozier et al. 2016 shows detection efficiencies of between 88% and 98%. Likely a surrogate for NavLock passage ~ 10% at most. Could not establish metric to determine differences. Recommend deletion.
TDG risk. To get at TDG in PUDs, look at forebay TDG at MCN. Make sure TDG is 90% for migration.	TDG: number of days over 120%, 125% at BON, MCN, CHJ	BON: 120 = 10.8%; 125 = 3.3% MCN: 120 = 6.8%; 125 = 2.1% CHJ: 120 = 0.0%; 125 = 0.0% Under NAA minor negative impacts expected to migrating Sockeye Salmon.	BON: 120 = 10.6; 125 = 2.9 MCN: 120 = 6.8; 125 = 1.8 CHJ: 120 < 0.1% ; 125 = 0.0% No difference from NAA	BON: 120 = 8.9; 125 = 2.4% MCN: 120 = 4.3; 125 = 1.2 CHJ: 120 < 0.0% ; 125 = 0.0% Negligible decrease in risk of gas bubble disease from TDG under MO2	BON: 120 = 10.7; 125 = 2.3% MCN: 120 = 9.4; 125 = 1.4 CHJ: 120 < 0.0% ; 125 = 0.0% No difference from NAA	BON: 120 = 25.8; 125 = 3.7 MCN: 120 = 13.3; 125 = 3.0 CHJ: 120 < 0.1%; 125 = 0.0% Minor Increase over those of NAA would increase risk of gas bubble disease	Sockeye are susceptible to TDG, could become an issue. Late 90's report. Check Chief Joe TDG. Should see higher TDG.
Structures affect upstream passage – spawning success. The Dalles ladder?	Look at structural measures again - are there any that should change delays?	Outputs: Spillway weirs may have greater potential for fallback - check on timing of current weir operation vs new weirs.	–	–	–	–	Delays at Tumwater Dam, but not much problem in the Columbia River dams. For Upper Columbia sockeye, fallback is highest at Bonneville then Wells. However, fallback is not significant predictor of survival for UC Sockeye. Not a predictor of effects at alternatives - Delete.
Flows affect adult migration. Sockeye migrate faster at higher flows, but are likely confounded by temperature. Flow is not a significant predictor of UC sockeye salmon survival. Use temperature instead.	Flows and temp links. Peak flow dates 90th percentile of high flows. datesadd temp.	–	No difference from NAA.	–	–	MO4 flows are slightly higher during early part of adult migration on low water years - expect a minor improvement in adult conversion.	–

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Tiffen et al., 2018

3.4.1.1 Upper Columbia River Summer/Fall-Run Chinook Salmon

Table 3-11. Upper Columbia River Summer and Fall Chinook Qualitative Effects Analysis Matrix

Affected Environment Important Relationships/Criteria	Affected Environment Metric	Environmental Consequences NAA	Environmental Consequences MO1	Environmental Consequences MO2	Environmental Consequences MO3	Environmental Consequences MO4	Notes
Spawning, Incubation, and Egress							
Vernita Bar operations is in place to protect redds below Priest Rapids Dam.	Frequency of meeting Vernita Bar operation.	Frequency of meeting the operation = 100%. No change from NAA	Frequency of meeting the operation = 99.9%. No change from NAA.	Frequency of meeting the operation = 99.9%. No change from NAA.	Frequency of meeting the operation = 99.9%. No change from NAA.	Frequency of meeting the operation = 99.9%. No change from NAA.	Note: We always meet Vernita Bar operation unless VDL minimum. Mid-Columbia Fall Chinook only (not Upper Columbia River Summer/Fall or Lower Columbia Fall Chinook). Metric was not useful for separating alternatives.
Flow from CHJ October 1 to November 7 (spawning) and February 1 to March 15 (emergence) provides water depth for spawning and cleaning gravel for redds. Relevant for both dewatering and raising tailwater too high.	Option 1: Ordinary high water line in the Chief Joe tailrace from October 1-Nov 7 and Feb 1-March 15. Option 2: CHJ tailwater elevation (Oct 1 – Nov 7 and Feb 1 – March 15). Wildlife team assisting with this for #1, if not, will do #2.	In progress. See notes.	In progress. See notes.	In progress. See notes.	In progress. See notes.	In progress. See notes.	The Columbia River Bridge at Bridgeport, State Route 17 spanning Columbia River, Bridgeport, Douglas County, WA bridge is a flow constriction. Metric withdrawn, no meaningful change anticipated. Upper Columbia River Summer/Fall Chinook only (not Mid-Columbia Fall or Lower Columbia Fall Chinook)
Temperature relationship for spawning areas.	Change in water temperature in spawning areas in winter (October 1 - November 7). Temperatures over 20C reduce survival.	No expected change over next 25 years. High water temp. 303(d) listing for CHJ tailrace. In Lower Columbia (MCN-below Bonneville), climate change could increase summer temperatures, but otherwise no change expected, will remain on 303(d) list. No days over 20°C.	No expected change from NAA. No days over 20°C.	Similar or slightly cooler (1°-2°F), except Average Flow/ Average Temperature and Low Flow/High Temperature in the spring and early summer are expected to be 1°to 2°F warmer in CHJ tailrace. In Lower Columbia (MCN-below Bonneville), no expected change. No days over 20°C.	Slightly cooler (0.5°-2°F) in CHJ tailrace. In Lower Columbia (MCN-below Bonneville), possible diel and day-to-day variability, but little expected temperature change. No days over 20°C.	Little change except for low flow scenarios where spring/summer temperatures are 1.5°-3°F higher in CHJ tailrace. In Lower Columbia (MCN-below Bonneville), Little or no expected change. No days over 20°C.	Does a <3° F change produce a meaningful change for spawning? Placeholder: need literature for spawning temperature range. If so, metric would be frequency of deviation from spawning temp range. No impact from the metric for this effect. There are no days over 20°C in any alternative for Oct and Nov. Upper Columbia Summer/Fall, Mid-Columbia Fall and Lower Columbia Fall Chinook (all three groups).
Elevated TDG may affect summer and fall Chinook salmon.	TDG in spawning areas from March 1 – Sept 1. March 1-Sept 1 covers emergence period when spill may affect spawning areas. Many juveniles between confluence of Okanogan and GCL. TDG over 120% would reduce egg and fry survival. Percent of days over 120% at MNC Forebay and CHJ TW.	Deflectors will continue to be operational. Will decrease forebay TDG; some violations to state/tribal water quality standards will continue. TDG. 303(d) listing likely to remain in place. Days TDG over 120% MCN = 0.7% CHJ = 0.0%	Days TDG over 120% MCN = 0.5% CHJ = 0.1% No change from NAA.	Days TDG over 120% MCN = 0.3% CHJ = 0.1% No change from NAA.	Days TDG over 120% MCN = 0.1% CHJ = 0.0% No change from NAA.	Days TDG over 120% MCN = 0.2% CHJ = 0.1% No change from NAA.	FPC TDG monitoring possibly; Chelan Public Utility Department reports may have differential effects of TDG on yearling/subyearlings. Smaller summer/fall or fall migrants tend to be smaller, may be more susceptible than yearlings to TDG. Rearing habitat for juveniles (in-river and hatcheries); degraded with elevated TDG, restricting upper part of shallow water. Metric is not effective at separating alternatives. Upper Columbia Summer/Fall, Mid-Columbia Fall and Lower Columbia Fall Chinook (all three groups)

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Affected Environment Important Relationships/Criteria	Affected Environment Metric	Environmental Consequences NAA	Environmental Consequences MO1	Environmental Consequences MO2	Environmental Consequences MO3	Environmental Consequences MO4	Notes
Juvenile Mainstem Rearing and Passage							
Juvenile rearing habitat (JDA pool).	Presence of the pool; May also add JDA flow/velocity or stage criteria, if relationship known.	Prof. Kennedy (UI), Jessica Miller? What proportion of Upper Columbia summer/fall Chinook are rearing/spending time in reservoirs? WDFW Andrew Murdock. Can be highly variable among brood years. Kirk will also check scales for life history strategies too.	—	—	—	—	Check Tiffan (2002) for flow/stage relationships. Model has several inputs, including bathymetry and local calculations like an HSI. Difficult to pull specific relationships tied to operations without running model with current bathymetry. No flow/ stage relationships in Tiffan (2002). The farther downstream, the faster Upper Columbia Summer/Fall Chinook migrate. Some rear while moving downstream. Most rearing habitat in the JDA pool is in the upper third, shallow water habitat. No information submitted on specific temp criteria or months in tech review. Criteria needed. Metric not used. Upper Columbia Summer/Fall and Mid-Columbia Fall Chinook only (not Lower Columbia Fall Chinook).
Water temperature in mainstem Lower Columbia River affects piscine predation rate during juvenile outmigration.	Water temperatures during outmigration period as surrogate for piscine predator activity at Lower Columbia projects. Use McNary as reference point for mainstem estimate. Mean Temperature and Percent days over 20°C from May 1 thru Aug 31 (90% of the run). Reported as relative risk of predation.	Average 18.1°C Days over 20°C = 41.6%	No change in temp. Mean Temp = 18.1°C Days over 20°C = 41.4% Piscine predation rate would not change under MO1.	No change in temp. Mean Temp = 18.1°C Days over 20°C = 41.4% Piscine predation rate would not change under MO1.	Mean Temp = 18.1°C Days over 20°C = 43.2% 2 More days over 20°C Negligible increase in predation rate under MO3.	No change in temp. Mean Temp = 18.1°C Days over 2°C = 41.3% Piscine predation rate would not change under MO1. McNary measure is likely driving this, per water quality presentation.	Tiffan & Connor (2018) for piscine predators. FPC reports on columnaris; [Hyatt et al. (2003), Keefer et al. (2008); Keefer et al. (2019)]. Smallmouth, pikeminnow, and walleye increasing; birds reduced. Warmer temperatures and concentrations of juveniles/predators at dam structures make juvenile salmonids more susceptible to piscine predators (channel catfish, walleye, pikeminnow, smallmouth bass. Affects survival via predation and increased energetic requirements; disease (columnaris). Compensatory mortality (swamping predators) - easier to account for spring migrants than fall chinook; not a metric per se but account for this in predation effects analysis/estimates. Note: no standard deviation available to estimate statistical significance. Upper Columbia Summer/Fall, Mid-Columbia Fall and Lower Columbia Fall Chinook (all three groups)

Affected Environment Important Relationships/Criteria	Affected Environment Metric	Environmental Consequences NAA	Environmental Consequences MO1	Environmental Consequences MO2	Environmental Consequences MO3	Environmental Consequences MO4	Notes
Predation in reservoirs. Changes in the reservoir environment (relative to the NAA) may change the susceptibility of juvenile Upper Columbia Summer and Fall Chinook salmon to avian predation (gulls, cormorants, terns, pelicans). Blalock Island inundation measure in MO1 is designed to prevent nesting.	Travel time (exposure) and change in susceptibility to predation events. No Travel time estimates for these fish. No Surrogates used. Avian Habitat changes for qualitative analysis.	Estimate for travel time? Maybe can do water travel time as next best option if not fish travel time. Would need to caveat. NWFSC nor FPC have estimates from MCN-BON for NAA.	Travel time: Turbine passage would likely decrease with increased spill in MO1 ~ decreased travel time. Decrease in predation risk from Blalock island inundation measure.	Travel time: Turbine passage would likely increase with decreased spill in MO1 ~ increased travel time.	Travel time: In addition to other measures, JDA full pool will affect travel time. Turbine passage would likely decrease with increased spill in MO3 until July 31 ~ decreased travel time.	Travel time: Turbine passage would likely decrease with increased spill in MO4 ~ decreased travel time.	Compensatory mortality (swamping predators) - easier to account for spring migrants than fall chinook; not a metric per se but account for this in predation effects analysis/estimates. Turbines have been traditionally associated with higher injury/ mortality than other passage routes. Important: check how many juvenile migrants are coming out after July 31st. Check PUD reports too. Upper Columbia Summer/Fall, Mid-Columbia Fall and Lower Columbia Fall Chinook (all three groups)
Higher turbidity decreases predation rates. Higher turbidity within a range hides juveniles so predation rates would decrease.	(WQ) total suspended solids/turbidity metric.	No expected change over time for CHJ tailrace. From MCN-Warrendale, turbidity not expected to change over time, but highly dependent on watershed land-use practices.	No expected change relative to NAA.	No expected change relative to NAA.	No expected change relative to NAA until McNary pool. Snake River under MO3 is expected to show an increase in turbidity year round, but especially during runoff. Breaching of the lower Snake River dams may slightly decrease predation risk due to increased turbidity.	No expected change over time for CHJ tailrace. Drawdown to MOP may have minor turbidity impacts; impacts expected to be minor in large reservoirs.	Upper Columbia Summer/Fall, Mid-Columbia Fall and Lower Columbia Fall Chinook (all three groups).
BON – BON (Estuary, Plume, Ocean)							
Rearing habitat in Columbia River estuary?	Change in shallow water habitat (SWH) availability downstream of Bonneville Dam. No Analysis conducted	Restoration monitoring reports for information. Maybe would use more under breach, but speculative. No Change in water elevation	In progress. See Wildlife Results No change from NAA	In progress. See Wildlife Results No change from NAA	In progress. See Wildlife Results No change from NAA	In progress. See Wildlife Results No change from NAA	Upper Columbia Summer/Fall, Mid-Columbia Fall and Lower Columbia Fall Chinook (all three groups)

Affected Environment Important Relationships/Criteria	Affected Environment Metric	Environmental Consequences NAA	Environmental Consequences MO1	Environmental Consequences MO2	Environmental Consequences MO3	Environmental Consequences MO4	Notes
Adult Mainstem Passage							
Water temperatures above 20°C (68°F) can cause adult salmon to stop or delay their migration, may increase fallback at a dam, and may increase fish susceptibility to disease.	Frequency of mainstem water temperatures from Lower Granite to Bonneville that exceed 20°C (68°F) from July 1 – November 30. As measured at McNary tailrace. Average number of days exceeding 20°C in 80 year water record. Frequency of water temperatures from Lower Granite to Bonneville that exceed 20 °C (68 °F) from May 15 – October 31. MCN TW	Climate change could increase summer temperatures, but otherwise no change expected, Will remain on 303(d) list. Percent of Days over 20°C = 34.1% (57.6 Days)	No expected change. Percent of Days over 20°C = 34.3% (57.9 Days)	No expected change. Percent of Days over 20°C = 34.1% (57.6 Days)	Possible diel and day-to-day variability, but little expected change. Percent of Days over 20°C = 33.5% (56.6 Days)	Minor temperature increase during the summer in low flow years below McNary Dam, no expected change downstream to Warrendale. Percent of Days over 20°C = 34.1% (57.6 Days)	May be able to get a list of references from the EPA Coldwater Refuges report. Chinook have slightly higher thermal threshold relative to steelhead. Update: tentatively, draft in June/July and final in November 2019. Increased temperatures reduce survival and spawning success (gamete viability included). Increased adult straying with elevated temps (e.g. Deschutes/thermal refuges) - see Snake River Sockeye for DWA language for adults. Upper Columbia Summer/Fall, Mid-Columbia Fall and Lower Columbia Fall Chinook (all three groups). Metric did not separate alternatives.
Okanogan Upper Columbia Summer/Fall Chinook salmon will hold at mouth of Okanogan when temperatures are 21°C and above, and will not move upstream until temperatures in the Okanogan are below 21°C. Mainstem temperatures must stay below 20°C for holding area until Okanogan fish can pass.	Frequency of water temperatures exceeding 21°C (70°F) during summer – fall (July 1 – September 15) at Chief Joseph tailrace. Frequency of water temperatures exceeding 21°C (70°F) during summer fall at the mouth of the Okanogan. Measured broad-scale as change in Chief Joseph tailrace temperature relative to NAA.	No expected change. High water temp. 303(d) listing. Days above 21°C = 0.0%; over 20°C = 0.0%	No expected change. Days above 21°C = 0.0%; over 20°C = 0.0%	No expected change. Days above 21°C = 0.0%; over 20°C = 0.1%	Slightly cooler (0.5°-2°F) temperature in Chief Joseph tailrace. Days above 21°C = 0.0%; over 20°C = 0.0%	Little change except for low flow scenarios where spring/summer temperatures are 1.5°-3°F higher in Chief Joseph tailrace. Days above 21°C = 0.0%; over 20°C = 1.1% Slight increase in temperatures that may impact fish holding at the Okanogan River.	Upper Columbia Summer/Fall Chinook only (not Mid-Columbia Fall or Lower Columbia Fall Chinook)
Adult ladder differentials of ?2°C can delay adult migration.	Temperature difference between forebay and tailrace of =2 °C (=3.6 °F) from June 1 to September 30, Bonneville to McNary. Frequency of adult ladder temperature differentials of =2 °C (=3.6 °F)	Days of exceedance at MCN = 2.8%	Days of exceedance at MCN dam = 4.2%	Days of exceedance at MCN dam = 2.9%	Days of exceedance at MCN dam = 3.1%	Days of exceedance at MCN dam = 3.8%	Most work has been at the lower Snake projects; unclear if info is available for Lower Columbia. We don't know of any ladder delays in the Lower Columbia due to ladder differentials at this time. Upper Columbia Summer/Fall, Mid-Columbia Fall and Lower Columbia Fall Chinook (all three groups). Metric not effective in selecting an alternative.

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Tiffan, 2002

3.5 MIDDLE COLUMBIA RIVER SALMON AND STEELHEAD

3.5.1 Mid-Columbia Spring-Run Chinook Salmon

See Upper Columbia Spring Chinook Salmon COMPASS results

3.5.2 Mid-Columbia River Steelhead

See Upper Columbia Steelhead COMPASS results

3.6 SNAKE RIVER SALMON AND STEELHEAD

3.6.1 Snake River Spring/Summer-Run Chinook Salmon

3.6.1.1 COMPASS Juvenile Results

Table 3-12. Summary results for Snake River Spring/Summer Chinook by Alternative.

Alternative	Mean Survival	95% CI Survival	Mean Arrival at BON	Proportion Destined for Transport	Mean Gas Exposure	Proportion Powerhouse Passage	Mean Travel time (LGR-MCN) (Days)	Mean Travel time (MCN-BON) (Days)	Mean Migration Rate (LGR-MCN) (mi/day)	Mean Migration Rate (MCN-BON) (mi/day)	Mean Temp Experience (Snake)	Mean Temp Experience (Columbia)	Mean Flow Experience (Snake)	Mean Flow Experience (Columbia)	Mean Gas Experience (Snake)	Mean Gas Experience (Columbia)	Avg. Num Bypasses	Avg. Num Turbine Passages	Avg. Num Spill Passages
NAA	0.5037	0.4574-0.5444	136.35	0.3851	114.70	0.281	10.20	7.51	12.75	23.19	11.34	13.41	90.49	272.84	112.05	115.13	1.43	0.82	5.75
MO1	0.5096	0.4618-0.5519	136.18	0.3779	114.89	0.235	10.10	7.27	13.06	23.30	11.34	13.44	90.77	267.67	112.44	115.24	1.15	0.73	6.12
MO2	0.5010	0.4623-0.5344	135.39	0.4742	112.76	0.378	10.62	7.72	12.32	22.73	11.24	13.33	90.29	268.73	110.77	112.12	1.15	1.87	4.98
MO3-GRNIMN-WH	0.5510	0.4909-0.6070	137.78	0.0000	111.76	0.168	8.45	6.98	12.39	24.41	11.73	13.77	91.48	271.95	101.08	117.33	0.19	0.48	3.33
MO3-SAL-WH	0.5999	0.5476-0.6462	132.90	0.0000	111.45	0.165	4.65	7.50	20.28	22.43	11.22	12.95	88.97	258.67	101.01	116.86	0.18	0.48	3.34
MO3-SAL-W	0.5992	Not Estimated	132.94	0.0000	111.45	0.185	4.65	7.54	20.28	22.40	11.22	12.96	88.97	258.82	101.01	116.86	0.21	0.53	3.26
MO3-SNK-WH	0.6318	0.5770-0.6756	131.23	0.0000	111.39	0.161	3.58	7.63	27.22	21.94	11.09	12.74	88.29	255.19	101.00	116.78	0.18	0.47	3.36
MO4	0.5070	0.4603-0.5491	138.33	0.0725	118.14	0.061	9.23	6.95	14.00	24.37	11.49	13.62	92.27	279.43	116.02	118.66	0.24	0.25	7.51

3.6.2 CSS Juvenile Results

3.6.2.1 CSS Juvenile metrics tables

Table 3-13. Predicted Snake River Spring/Summer Chinook juvenile survival (LGR-BON) with no surface passage (0%), 10%, 20%, and 30% surface passage efficiencies using the cohort-specific model

Alternative and Passage Efficiency	NAA 0%	MO1 0%	MO1 10%	MO1 20%	MO1 30%	MO2 0%	MO2 10%	MO2 20%	MO2 30%	MO3 0%	MO3 10%	MO3 20%	MO3 30%	MO4 0%	MO4 10%	MO4 20%	MO4 30%
Mean Survial	0.576	0.579	0.580	0.582	0.583	0.520	0.526	0.531	0.537	0.680	0.681	0.682	0.682	0.632	0.633	0.634	0.635
25%-75% inter-quartile range	0.485-0.675	0.488-0.678	0.489-0.679	0.491-0.681	0.493-0.682	0.420-0.623	0.426-0.628	0.432-0.634	0.439-0.639	0.603-0.770	0.604-0.771	0.605-0.772	0.605-0.772	10.6 - 16.1)	0.546-0.732	0.547-0.733	0.549-0.735

Table 3-14. Predicted Snake River Spring/Summer Chinook Juvenile Chinook Travel Times (LGR-BON) with No Surface Passage (0%), 10%, 20%, and 30% Surface Passage Efficiencies Using the Cohort-Specific Model

Alternative by Passage Efficiency	NAA 0%	MO1 0%	MO1 10%	MO1 20%	MO1 30%	MO2 0%	MO2 10%	MO2 20%	MO2 30%	MO3 0%	MO3 10%	MO3 20%	MO3 30%	MO4 0%	MO4 10%	MO4 20%	MO4 30%
Mean Travel Time	15.8	15.7	15.6	15.5	15.5	18.3	18.0	17.8	17.5	12.5	12.5	12.5	12.4	13.7	13.7	13.7	13.6
25%-75% inter-quartile range	12.2-18.7	12.1-18.4	12.1-18.4Fs	12.0-18.3	12.0-18.2	13.8-21.9	13.6-21.6	13.4-21.3	13.3-21.0	9.8-14.7	9.8-14.7	9.8-14.6	9.8-14.6	10.6-16.1	10.6-16.)	10.5-16.0	10.5-16.0

Table 3-15. Mean Seasonal Average PITPH (95% confidence interval) for Snake River Spring/Summer Chinook Over the 80-Year Water Record for each CRSO EIS Alternative Used in the CSS Modeling

Species	EIS Alternative	No PHSP	PSP–10% Efficiency	PSP–20% Efficiency	PSP–30% Efficiency
Chinook	NAA ^A	2.15 (2.06-2.23)	–	–	–
Chinook	MO1	1.85 (1.72-1.97)	1.81 (1.69-1.94)	1.78 (1.65-1.90)	1.74 (1.62-1.87)
Chinook	MO2	3.90 (3.82-3.98)	3.76 (3.68-3.84)	3.62 (3.54-3.70)	3.48 (3.41-3.56)
Chinook	MO3	0.62 (0.57-0.67)	0.60 (0.55-0.65)	0.58 (0.53-0.63)	0.56 (0.51-0.61)
Chinook	MO4	0.45 (0.40-0.50)	0.41 (0.37-0.46)	0.38 (0.33-0.42)	0.34 (0.30-0.38)

Notes: ^A There are no PSP structures in the NAA. Therefore, the CSS did not estimate PITPH under the 10%, 20%, and 30% efficiencies for this alternative.

PSP refers to the addition of Powerhouse Surface Passage structures, with assumed 10%, 20% and 30% efficiencies.

3.6.2.2 TDG Tool Results

Table 3-16. Mean Reach Average Exposure (RAE) results for juvenile Snake River Spring/Summer Chinook in both Allriver (LWG-BON) and Lower Columbia (MCN – BON) reaches, under the different alternatives.

Alternative	RAE (%) for Allriver (LWG-BON)	RAE (%) for Lower Columbia (MCN-BON)
NAA	115.1	115.4
MO1	115.5	115.6
MO2	112.8	112.3
MO3.SAL	109.2	116.6
MO3.GRNIMN	109.3	116.8
MO3.SNK	109.2	116.6
MO4	119.6	119.2

Note: The Allriver model run used transportation rules, whereas the Lower Columbia run did not.

Table 3-17. Mean survival results for juvenile Snake River Spring/Summer Chinook in both Allriver (LWG-BON) and Lower Columbia (MCN – BON) reaches, under the different alternatives.

Alternative	Survival (%) for Allriver (LWG-BON)	Survival (%) for Lower Columbia (MCN-BON)
NAA	97.3	98.4
MO1	96.9	98.5
MO2	98.7	99.2
MO3.SAL	97.7	97.7
MO3.GRNIMN	97.8	97.8
MO3.SNK	97.7	97.7
MO4	82.8	95.7

Note: The Allriver model run used transportation rules, whereas the Lower Columbia run did not.

3.6.3 Adult Results Summary

3.6.3.1 Adult metrics:

Table 3-18. Predicted Snake River spring/summer Chinook Ocean Survival Rates with No Surface Passage (0%), 10 %, 20%, and 30% Surface Passage Efficiencies using the Cohort-Specific Model

Alternative by Species	NAA 0%	MO1 0%	MO1 10%	MO1 20%	MO1 30%	MO2 0%	MO2 10%	MO2 20%	MO2 30%	MO3 0%	MO3 10%	MO3 20%	MO3 30%	MO4 0%	MO4 10%	MO4 20%	MO4 30%
Mean ocean survival	0.036	0.038	0.039	0.039	0.039	0.025	0.026	0.027	0.028	0.059	0.059	0.059	0.060	0.055	0.056	0.056	0.057
25%-75% inter-quartile range	0.010-0.041	0.011-0.043	0.011-0.043	0.011-0.044	0.011- 0.045	0.007-0.027	0.007-0.028	0.007-0.029	0.008-0.030	0.017-0.069	0.017-0.069	0.017-0.070	0.017-0.070	0.016-0.065	0.016-0.065	0.016-0.066	0.016 0.067

Table 3-19. Predicted Snake River spring/summer Chinook SARs and Mean Transport: In-river (TIR) for the wild portion with no surface passage (0%), 10%, 20%, and 30% surface passage efficiencies using the cohort-specific model

Alternative by Species	NAA 0%	MO1 0%	MO1 10%	MO1 20%	MO1 30%	MO2 0%	MO2 10%	MO2 20%	MO2 30%	MO3 0%	MO3 10%	MO3 20%	MO3 30%	MO4 0%	MO4 10%	MO4 20%	MO4 30%
SAR	0.020	0.021	0.021	0.021	0.022	0.012	0.013	0.014	0.014	0.042	0.042	0.043	0.043	0.034	0.034	0.035	0.035
25%-75% inter-quartile range	0.005-0.022	0.006-0.022	0.006-0.023	0.006-0.023	0.006-0.023	0.003-0.013	0.003-0.014	0.003-0.015	0.004-0.015	0.012-0.048	0.012-0.048	0.012-0.048	0.012-0.048	0.009-0.037	0.009-0.038	0.009-0.038	0.009-0.039
TIR (wild SR sp/su Chinook)	0.86	0.69	0.69	0.68	0.68	1.29	1.26	1.22	1.18	NA	NA	NA	NA	0.58	0.57	0.56	0.56
25%-75% inter-quartile range	0.64-1.03	0.51-0.82	0.51-0.82	0.50-0.82	0.50-0.81	0.95-1.54	0.93-1.50	0.90-1.46	0.86-1.41	NA	NA	NA	NA	0.42-0.69	0.42-0.68	0.41-0.67	0.41-0.67

Table 3-20. 50th Quantile of the Geometric Mean Abundance for Snake River Spring-Run Chinook Salmon Populations predicted by NWFSC Life Cycle Model

Chinook Population and Totals	NAA	MO1	MO1 + 10% LM	MO1 + 25% LM	MO1 + 50% LM	MO2	MO3.SAL	MO3.SAL + 10% LM	MO3.SAL + 25% LM	MO3.SAL + 50% LM	MO4	MO4 + 10% LM	MO4 + 25% LM	MO4 + 50% LM
Bear Valley	291	302	329	365	430	324	325	396	502	706	185	233	298	430
Big Creek	150	149	159	169	184	154	159	180	205	275	112	129	152	184
Camas Creek	61	62	63	64	72	63	62	68	78	95	49	55	61	73
Loon Creek	56	58	62	67	75	62	61	76	88	118	39	48	57	77
Marsh Creek	143	145	163	189	231	175	174	225	283	445	79	108	145	255
Sulphur Creek	56	56	58	65	74	61	59	68	88	117	35	44	57	74
Secesh	291	295	306	324	363	309	308	354	415	529	219	250	290	368
SF Salmon	479	484	508	541	604	510	511	584	686	875	361	406	488	599
East Fork Salmon	51	54	66	83	110	70	88	135	194	330	22	38	68	136
Lemhi	38	36	47	62	88	53	75	123	197	382	11	26	51	129
North Fork Salmon	14	16	18	21	26	19	24	38	63	118	6	10	19	40
Pahsimeroi	133	142	151	180	225	159	192	248	367	536	68	96	158	280
Panther	28	29	31	40	50	34	42	57	84	131	14	19	35	64
Upper Main Salmon	487	502	517	553	627	518	564	659	819	1060	353	429	521	701
Valley	50	57	58	69	84	61	77	107	149	235	24	39	62	111
Yankee Fork	22	24	28	35	46	28	42	62	93	161	10	15	29	64
Total All Populations	2351	2411	2563	2826	3290	2602	2764	3378	4311	6113	1590	1944	2489	3586
Change from NAA	N/A	60	212	474	938	250	413	1027	1960	3761	-761	-407	138	1235
% Change	N/A	3%	9%	20%	40%	11%	18%	44%	83%	160%	-32%	-17%	6%	53%

Table 3-21. Median Abundance for Snake River Spring-Run Chinook Salmon populations predicted by CSS

Salmon Population or Totals	NAA	MO1	MO1 + 10% LM	MO1 + 25% LM	MO1 + 50% LM	MO2	MO3.SAL	MO3.SAL + 10% LM	MO3.SAL + 25% LM	MO3.SAL + 50% LM	MO4	MO4 + 10% LM	MO4 + 25% LM	MO4 + 50% LM
Upper Grande Ronde	258	289	N/A	N/A	N/A	128	766	N/A	N/A	N/A	633	N/A	N/A	N/A
Imnaha	2549	2649	N/A	N/A	N/A	1573	5351	N/A	N/A	N/A	4696	N/A	N/A	N/A
Lostine/Wallowa	742	787	N/A	N/A	N/A	436	1655	N/A	N/A	N/A	1442	N/A	N/A	N/A
Minam	1140	1196	N/A	N/A	N/A	705	2416	N/A	N/A	N/A	2126	N/A	N/A	N/A
Wenaha	1193	1261	N/A	N/A	N/A	538	3306	N/A	N/A	N/A	2792	N/A	N/A	N/A
Total	6114	6428	–	–	–	3508	14055	–	–	–	12159	–	–	–
Change from NAA	–	314	–	–	–	-2606	7941	–	–	–	6045	–	–	–
% Change	–	5%	–	–	–	-43%	130%	–	–	–	99%	–	–	–

3.6.3.2 NWFSC Life Cycle Model Results

Table 3-22. NWFSC Life Cycle Model Snake River Spring-Summer Run Chinook Salmon SAR (Lower Granite to Bonneville) Results

Alternative	SAR inriver	SAR transport	In-River Survival	Transported Survival	Proportion Transported	LGR- BON SAR	SAR Change from NAA	% Change
NAA	0.0155	0.0105	0.5037	0.98	0.3851	0.0088		
MO1	0.0155	0.0104	0.5096	0.98	0.3779	0.0088	0.0000	0%
MO1 + 10% LM	0.0171	0.0104	0.5096	0.98	0.3779	0.0093	0.0005	5%
MO1 + 25% LM	0.0194	0.0104	0.5096	0.98	0.3779	0.0100	0.0012	14%
MO1 + 50% LM	0.0233	0.0104	0.5096	0.98	0.3779	0.0112	0.0024	28%
MO1 + 100% LM	0.0311	0.0104	0.5096	0.98	0.3779	0.0137	0.0049	56%
MO2	0.0158	0.0105	0.5010	0.98	0.4742	0.0090	0.0002	3%
MO3.GRNIMN	0.0144	0	0.5510	0.98	0.0000	0.0079	-0.0009	-10%
MO3.GRNIMN + 10% LM	0.0159	0	0.5510	0.98	0.0000	0.0088	0.0000	0%
MO3.GRNIMN + 25% LM	0.018	0	0.5510	0.98	0.0000	0.0099	0.0011	13%
MO3.GRNIMN + 50% LM	0.0217	0	0.5510	0.98	0.0000	0.0120	0.0032	36%
MO3.GRNIMN + 100% LM	0.0289	0	0.5510	0.98	0.0000	0.0159	0.0071	81%
MO3.SAL	0.0166	0	0.5999	0.98	0.0000	0.0100	0.0012	13%
MO3.SAL + 10% LM	0.0182	0	0.5999	0.98	0.0000	0.0109	0.0021	24%
MO3.SAL + 25% LM	0.0207	0	0.5999	0.98	0.0000	0.0124	0.0036	41%
MO3.SAL + 50% LM	0.0249	0	0.5999	0.98	0.0000	0.0149	0.0061	70%
MO3.SAL + 100% LM	0.0331	0	0.5999	0.98	0.0000	0.0199	0.0111	126%
MO3.SNK	0.0171	0	0.6318	0.98	0.0000	0.0108	0.0020	23%
MO3.SNK + 10% LM	0.0188	0	0.6318	0.98	0.0000	0.0119	0.0031	35%
MO3.SNK + 25% LM	0.0214	0	0.6318	0.98	0.0000	0.0135	0.0047	54%
MO3.SNK + 50% LM	0.0257	0	0.6318	0.98	0.0000	0.0162	0.0074	85%
MO3.SNK + 100% LM	0.0342	0	0.6318	0.98	0.0000	0.0216	0.0128	146%
MO4	0.0148	0.0103	0.5070	0.98	0.0725	0.0077	-0.0011	-13%
MO4 + 10% LM	0.0163	0.0103	0.5070	0.98	0.0725	0.0084	-0.0004	-5%
MO4 + 25% LM	0.0185	0.0103	0.5070	0.98	0.0725	0.0094	0.0006	7%
MO4 + 50% LM	0.0222	0.0103	0.5070	0.98	0.0725	0.0112	0.0024	27%
MO4 + 100% LM	0.0296	0.0103	0.5070	0.98	0.0725	0.0147	0.0059	67%

3.6.4 Tables 3-23 through 3-39 NWFSC Life Cycle Model abundance results, by population, of Upper Snake River Spring/Summer Run Chinook Salmon.

Table 3-23. Quantiles (Q) of the Geometric Mean Abundance (across all years) for Bear Valley Creek

Alternative	2.5 Q	25 Q	50 Q	75 Q	97.5 Q
NAA	4.2	173.6	291.1	445.7	839
MO1	2.7	182.6	302.3	474.6	891.4
MO1 + 10% LM	5.5	198.6	328.7	486.4	915.9
MO1 + 25% LM	10.6	217.7	365.3	552.8	1047.3
MO1 + 50% LM	15.9	283.8	430.3	609.2	1095.4
MO1 + 100% LM	25.4	363.7	539	763.7	1354.3
MO2	9.1	208.2	324.3	476.5	873.2
MO3.GRNIMN	0.6	100.5	196	315.3	613.6
MO3.GRNIMN + 10% LM	1.2	136.5	240.1	397.5	786.3
MO3.GRNIMN + 25% LM	1.1	190.2	333.1	505.8	976.5
MO3.GRNIMN + 50% LM	4.6	297.7	468.6	702.4	1288.5
MO3.GRNIMN + 100% LM	20.5	530.5	772.2	1086.2	1889.8
MO3.SAL	4.7	199.3	324.8	503	954.8
MO3.SAL + 10% LM	10.3	244.6	395.8	611.9	1142.9
MO3.SAL + 25% LM	16.2	326.3	501.8	743	1361.4
MO3.SAL + 50% LM	48.4	482.6	705.6	976.2	1715.6
MO3.SAL + 100% LM	178.9	797.9	1106.5	1506.7	2560.2
MO3.SNK	9.5	240.6	388.4	590.1	1110.4
MO3.SNK + 10% LM	22.6	297.1	478	684.7	1264.9
MO3.SNK + 25% LM	46.8	398.8	605.5	888.7	1617.3
MO3.SNK + 50% LM	71.3	545.7	808.8	1127	1973.7
MO3.SNK + 100% LM	188.9	900.7	1228.8	1647.8	2757.6
MO4	1.5	91.1	184.9	310.7	637.3
MO4 + 10% LM	1.4	127.9	232.6	380.6	758.3
MO4 + 25% LM	5.8	168.1	297.8	468.9	918.4
MO4 + 50% LM	15.7	275.7	430.2	643.4	1176.5
MO4 + 100% LM	52.2	480.6	717.6	1015.5	1812.9

Table 3-24. Quantiles (Q) of the Geometric Mean Abundance (across all years) for Big Creek

Alternative	2.5 Q	25 Q	50 Q	75 Q	97.5 Q
NAA	13.9	110.6	150	194.4	318.7
MO1	11.9	107.4	149.2	198.5	331.6
MO1 + 10% LM	24.4	116.9	158.9	207.3	340.8
MO1 + 25% LM	32.4	125.9	168.8	223.2	364.9
MO1 + 50% LM	30.6	138.2	184.4	240.6	389.8
MO1 + 100% LM	38.6	163.3	211.3	284.6	461.9
MO2	27.3	116.5	154.4	202.6	331.7
MO3.GRNIMN	5.6	84.2	116.4	157.5	265.9

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Alternative	2.5 Q	25 Q	50 Q	75 Q	97.5 Q
MO3.GRNIMN + 10% LM	19.8	100.4	135.3	177.6	293.2
MO3.GRNIMN + 25% LM	22.1	115.2	154.8	205.1	333
MO3.GRNIMN + 50% LM	36.3	153.5	200.3	256.5	409.4
MO3.GRNIMN + 100% LM	67.2	215.5	281.5	363.6	580.3
MO3.SAL	20.9	115	158.6	207.6	346.1
MO3.SAL + 10% LM	34.5	135.7	180	234.5	380.8
MO3.SAL + 25% LM	55.6	158.4	205.2	274.2	444.8
MO3.SAL + 50% LM	60.5	202	275.1	344.5	550.4
MO3.SAL + 100% LM	101.5	289.1	369.9	472.4	746.5
MO3.SNK	40.5	128.1	172.1	231.7	383.7
MO3.SNK + 10% LM	49.3	149.7	195.9	253.6	404
MO3.SNK + 25% LM	56.6	172.8	228.8	298.3	483.6
MO3.SNK + 50% LM	76.1	221.1	291.2	381.3	619
MO3.SNK + 100% LM	159.5	309.3	399.3	512	815.2
MO4	7.4	78.3	112.3	151.5	260.4
MO4 + 10% LM	10.5	91.5	129.1	170.8	287
MO4 + 25% LM	21.5	112.2	152.1	201.8	333.3
MO4 + 50% LM	40.5	140.6	183.9	239	383.4
MO4 + 100% LM	90.4	204.1	264.8	344.4	546.8

Table 3-25. Quantiles (Q) of the Geometric Mean Abundance (across all years) for Camas Creek

Alternative	2.5 Q	25 Q	50 Q	75 Q	97.5 Q
NAA	19.8	46.9	61.1	79.3	127.4
MO1	18.8	47.3	61.8	79.9	128.4
MO1 + 10% LM	12.1	47.9	62.7	81.8	132.3
MO1 + 25% LM	19.5	49.3	64	86.1	140.2
MO1 + 50% LM	20	54.6	71.7	90.3	143.8
MO1 + 100% LM	23.4	62.2	80.8	106.2	171.8
MO2	17.9	48.8	63.2	82.7	132.9
MO3.GRNIMN	12.3	37.8	49.8	65.6	106.6
MO3.GRNIMN + 10% LM	13.2	41.6	55.4	72.7	119.3
MO3.GRNIMN + 25% LM	18.8	47	62.5	81.6	133.5
MO3.GRNIMN + 50% LM	24.8	57.7	73.5	99.4	159.7
MO3.GRNIMN + 100% LM	21.2	75.1	100.2	130	212.3
MO3.SAL	17.6	46.6	62.1	81.2	132.3
MO3.SAL + 10% LM	18.5	51.6	68.1	89.5	143.4
MO3.SAL + 25% LM	23.9	59.8	78	103.2	165.3
MO3.SAL + 50% LM	24.5	71.9	95	124.9	204.1
MO3.SAL + 100% LM	28.2	93.4	123.4	164.3	270.4
MO3.SNK	23.2	51.1	68	91.6	151
MO3.SNK + 10% LM	18.7	56.8	75.5	96	154.6
MO3.SNK + 25% LM	23.6	63	83.9	112.5	186.6

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Alternative	2.5 Q	25 Q	50 Q	75 Q	97.5 Q
MO3.SNK + 50% LM	31.6	76.1	104.5	132.5	215.5
MO3.SNK + 100% LM	40.2	103.3	139.2	175.6	283.3
MO4	11.9	37.2	49.1	65.6	108.1
MO4 + 10% LM	13.5	41.3	54.6	70.5	112.7
MO4 + 25% LM	14.5	47.7	61.4	79.2	124.7
MO4 + 50% LM	23.1	54.7	72.9	95.7	156.9
MO4 + 100% LM	29.6	71.7	95.8	126.8	209.4

Table 3-26. Quantiles of the Geometric Mean Abundance (across all years) for Loon Creek

Alternative	2.5 Q	25 Q	50 Q	75 Q	97.5 Q
NAA	0.3	31.9	55.9	91.1	178.2
MO1	0	34.1	57.8	90.1	172.1
MO1 + 10% LM	0.8	34.5	61.8	92.3	178.3
MO1 + 25% LM	1.2	41.2	67.2	102.4	193.8
MO1 + 50% LM	0.8	48.1	75.4	110.1	202.5
MO1 + 100% LM	1.8	61.3	92.5	140.4	258.6
MO2	0.3	36.7	62.2	96.8	184.1
MO3.GRNIMN	0	20	39.8	64	128.5
MO3.GRNIMN + 10% LM	0.1	26.1	47.5	77.1	152.7
MO3.GRNIMN + 25% LM	0.8	33.6	58.8	90.8	176.4
MO3.GRNIMN + 50% LM	0.9	53	85.8	127.2	233.7
MO3.GRNIMN + 100% LM	2.3	84.3	128.3	188.8	340.9
MO3.SAL	0.2	36.2	61.1	94.2	180.4
MO3.SAL + 10% LM	1.2	42.1	75.6	114.5	223
MO3.SAL + 25% LM	1.4	54.3	87.9	136.3	259.2
MO3.SAL + 50% LM	5.8	78.1	117.7	172.7	314
MO3.SAL + 100% LM	7.5	126.7	181.1	261	460.7
MO3.SNK	0.4	40.3	71.3	111.2	217.6
MO3.SNK + 10% LM	0.9	48.2	81.6	125.8	242.1
MO3.SNK + 25% LM	1.8	63.5	101.2	148	274.6
MO3.SNK + 50% LM	1.1	87.1	132.2	193.7	352.5
MO3.SNK + 100% LM	9	136.5	206.3	291.4	522.8
MO4	0.2	18.4	39.3	63.5	126.5
MO4 + 10% LM	0.2	25.1	47.7	72.7	143.6
MO4 + 25% LM	0	35	56.9	92.3	175.8
MO4 + 50% LM	0.3	45.5	77.4	118.1	226.4
MO4 + 100% LM	5	80.4	126	182.8	336.2

Table 3-27. Geometric Mean Abundance (across all years) for Marsh Creek

Alternative	2.5 Q	25 Q	50 Q	75 Q	97.5 Q
NAA	0.6	71.7	142.9	279.2	587.4
MO1	0.2	73.2	145	276.2	575.3
MO1 + 10% LM	1.4	76.3	162.6	282.5	591.7

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Alternative	2.5 Q	25 Q	50 Q	75 Q	97.5 Q
MO1 + 25% LM	1.5	91.3	188.6	331.9	685.7
MO1 + 50% LM	1.1	121.9	230.5	401.3	816.8
MO1 + 100% LM	2.9	181.8	310.8	495	951.3
MO2	1.5	85.6	175	301.1	614
MO3.GRNIMN	0.6	34.3	92.2	185.4	387.1
MO3.GRNIMN + 10% LM	0.1	45.4	109	227.1	497.1
MO3.GRNIMN + 25% LM	0.5	80.1	174	311.7	653.2
MO3.GRNIMN + 50% LM	2.9	144.4	272	446.3	896.1
MO3.GRNIMN + 100% LM	17.4	310.1	484.2	746	1392.1
MO3.SAL	0.4	79.5	174	307.8	631.2
MO3.SAL + 10% LM	0.7	110.5	224.9	389.1	805.7
MO3.SAL + 25% LM	1.1	155.4	283.4	458.4	906.8
MO3.SAL + 50% LM	7.1	265.5	445.4	661	1237.8
MO3.SAL + 100% LM	51	483.9	722.6	1061.5	1913.6
MO3.SNK	0.7	103.2	216.6	374.4	778.1
MO3.SNK + 10% LM	2.8	148.2	264.2	440.7	875.3
MO3.SNK + 25% LM	7.5	196.6	341	565.7	1117.7
MO3.SNK + 50% LM	34.1	300.1	492.5	756.8	1432.5
MO3.SNK + 100% LM	44.6	555.5	818.9	1203.5	2175.5
MO4	0.1	29.6	79.2	173.7	382.6
MO4 + 10% LM	0.2	43.6	107.9	213	458.8
MO4 + 25% LM	0.5	70.5	144.7	281	595.3
MO4 + 50% LM	2	128.2	254.8	420.6	856.3
MO4 + 100% LM	4.5	265.9	436.7	671.3	1273.1

Table 3-28. Quantiles of the Geometric Mean Abundance (across all years) for Sulphur Creek

Alternative	2.5 Q	25 Q	50 Q	75 Q	97.5 Q
NAA	0.8	35.4	55.8	80.3	145.9
MO1	0.7	35.6	56.1	82.8	153.2
MO1 + 10% LM	0.9	37.7	58.4	83.3	151.3
MO1 + 25% LM	3	43.1	64.5	94.1	168.9
MO1 + 50% LM	1.9	50.2	74.1	102.8	181.5
MO1 + 100% LM	2.4	64	90.7	127.3	218.6
MO2	1.1	40	61.3	89.2	162
MO3.GRNIMN	0.3	21.4	37.6	59.3	114.6
MO3.GRNIMN + 10% LM	0.5	28.1	47.3	71.6	136.8
MO3.GRNIMN + 25% LM	0.9	38.3	58.5	87.1	159.9
MO3.GRNIMN + 50% LM	3.4	54.4	81.2	115.9	206.2
MO3.GRNIMN + 100% LM	10.7	88.9	127.7	173.3	299.8
MO3.SAL	1.7	36.2	59	86.9	162.3
MO3.SAL + 10% LM	3.9	45.7	67.9	100.1	181.3
MO3.SAL + 25% LM	4.8	60.1	87.9	124.2	219.9
MO3.SAL + 50% LM	9.7	82.1	117.2	158.8	271

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Alternative	2.5 Q	25 Q	50 Q	75 Q	97.5 Q
MO3.SAL + 100% LM	18.8	131.3	176.5	237	394.9
MO3.SNK	3.1	44.2	68.8	99.3	181.9
MO3.SNK + 10% LM	4.9	52.7	79.3	115	208.1
MO3.SNK + 25% LM	9.7	68.3	104.3	140.8	249
MO3.SNK + 50% LM	13.6	93.9	133.2	178.9	306.2
MO3.SNK + 100% LM	44.2	144.7	196.3	261.8	428.2
MO4	0.2	20.9	35.3	56.5	109.1
MO4 + 10% LM	0.2	27.1	44.3	66.3	125.2
MO4 + 25% LM	0.7	34	56.5	84.6	160
MO4 + 50% LM	2.5	51.4	74.2	103.2	178.6
MO4 + 100% LM	14.7	85.9	118.8	165.9	284.6

Table 3-29. Quantiles of the Geometric Mean Abundance (across all years) for Secesh River

Alternative	2.5 Q	25 Q	50 Q	75 Q	97.5 Q
NAA	19.3	218.8	291.1	375.5	608.9
MO1	17.1	217.5	295.1	381.5	627.2
MO1 + 10% LM	34.8	231.6	306	403.7	657
MO1 + 25% LM	6.6	247.9	323.6	427.5	692.3
MO1 + 50% LM	45.3	279	363.1	472.1	761.3
MO1 + 100% LM	42.7	332.7	423.9	551.3	871.3
MO2	7.8	232.3	309.1	396.8	642.7
MO3.GRNIMN	4.9	159.8	221.8	301	512
MO3.GRNIMN + 10% LM	11.4	186.1	259.4	342.2	574.1
MO3.GRNIMN + 25% LM	18.7	233.7	313.7	405.5	660.9
MO3.GRNIMN + 50% LM	27.5	293.6	393	521	860.6
MO3.GRNIMN + 100% LM	94.4	434.7	572.7	739.7	1195.3
MO3.SAL	23.1	226.1	308.3	405.8	675.3
MO3.SAL + 10% LM	17.9	263.7	354.3	470.5	779.8
MO3.SAL + 25% LM	54.5	316.8	414.9	539.3	863
MO3.SAL + 50% LM	90.6	394	528.5	681.2	1111.3
MO3.SAL + 100% LM	184.3	562.4	736.9	937.6	1495.1
MO3.SNK	42.1	259	350.7	456.7	750
MO3.SNK + 10% LM	61.4	298.4	390.5	516.9	844.1
MO3.SNK + 25% LM	89.6	343.4	454.7	604.6	992.6
MO3.SNK + 50% LM	150.4	447.1	576	750.6	1197.4
MO3.SNK + 100% LM	262.8	616.6	791.7	1032.2	1648.4
MO4	9.2	152.3	219.4	294.2	504.5
MO4 + 10% LM	5.7	175.2	250.1	330.4	562
MO4 + 25% LM	16.3	218.1	289.7	387.5	641.3
MO4 + 50% LM	26.3	272.8	368.4	484.3	799.4
MO4 + 100% LM	66.4	403.3	534.4	699.4	1140.5

Table 3-30. Quantiles of the Geometric Mean Abundance (across all years) for South Fork Salmon River

Alternative	2.5 Q	25 Q	50 Q	75 Q	97.5 Q
NAA	39.3	338.6	478.8	633.9	1076.6
MO1	32.1	353	484.3	643.3	1059
MO1 + 10% LM	41.2	363.1	508.4	676.9	1141.7
MO1 + 25% LM	37.7	396.9	541.2	709.8	1172.6
MO1 + 50% LM	37	448.5	604.3	809.4	1339.1
MO1 + 100% LM	103.9	539.9	726.9	966.3	1602.2
MO2	34.9	377.2	509.6	686.5	1144.3
MO3.GRNIMN	9.2	253.4	362.1	519.3	914
MO3.GRNIMN + 10% LM	5.2	299.2	417.1	586.6	1017.1
MO3.GRNIMN + 25% LM	39.1	356.8	510.9	684.2	1166.5
MO3.GRNIMN + 50% LM	60.5	479.1	661	889.9	1497.4
MO3.GRNIMN + 100% LM	63.4	723.4	961.4	1254.1	2045.5
MO3.SAL	8.4	369.5	511.4	694	1177.9
MO3.SAL + 10% LM	38.2	420.3	584.3	790.6	1335.2
MO3.SAL + 25% LM	37.7	505.6	685.7	921.4	1529.1
MO3.SAL + 50% LM	124	654.4	875.4	1162.9	1907.4
MO3.SAL + 100% LM	271.7	955.3	1270.9	1648.2	2684.7
MO3.SNK	29	402.9	584.3	779.8	1342.1
MO3.SNK + 10% LM	53.5	484.1	660.6	885	1474.7
MO3.SNK + 25% LM	112.8	548.6	777	1020.1	1722.9
MO3.SNK + 50% LM	208.6	725.9	956	1274	2079.5
MO3.SNK + 100% LM	394.6	1028.6	1371	1796	2938
MO4	9.8	247.2	361.3	505.2	892
MO4 + 10% LM	10.1	280.5	405.6	547.2	946.2
MO4 + 25% LM	29	343.9	487.5	656.8	1111.6
MO4 + 50% LM	57.1	445.6	598.7	826.9	1390.3
MO4 + 100% LM	126.2	657.9	889.4	1179.1	1959.5

Table 3-31. Quantiles of the Geometric Mean Abundance (across all years) for Valley Creek

Alternative	2.5 Q	25 Q	50 Q	75 Q	97.5 Q
NAA	4	75.3	107.8	148.2	257.3
MO1	3.1	79.2	110.9	153.7	263.8
MO1 + 10% LM	7.9	82	116.3	159.9	274.5
MO1 + 25% LM	8.6	86.8	123.8	166.8	285.8
MO1 + 50% LM	3.9	97.6	135.2	184.1	309.7
MO1 + 100% LM	23.4	122.4	161.6	222	362.6
MO2	7.3	85.2	121.9	162.7	277.2
MO3.GRNIMN	0.5	57	87	117.6	208.3
MO3.GRNIMN + 10% LM	0.3	64.3	95.3	133.8	232.8
MO3.GRNIMN + 25% LM	1.5	82.2	117.8	164.5	286

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Alternative	2.5 Q	25 Q	50 Q	75 Q	97.5 Q
MO3.GRNIMN + 50% LM	1	106.4	145.9	208.3	357.3
MO3.GRNIMN + 100% LM	41.4	162	213.8	297.6	500.2
MO3.SAL	14.1	80.6	114.8	160.2	278.6
MO3.SAL + 10% LM	5.3	96.1	132.5	189.4	324.9
MO3.SAL + 25% LM	21.5	115.4	157.3	217	365.4
MO3.SAL + 50% LM	30.1	147.7	201.8	275.2	464.6
MO3.SAL + 100% LM	62.8	210.7	288.5	379.5	628.6
MO3.SNK	3.7	92.1	130.3	180.7	309.1
MO3.SNK + 10% LM	6	103.5	149.1	203.4	353
MO3.SNK + 25% LM	11.5	130.5	182.6	249.1	425.1
MO3.SNK + 50% LM	15.7	165.9	224.4	297.7	494.1
MO3.SNK + 100% LM	72	237	314.2	429.4	707.2
MO4	1.5	52.5	80.3	113	201.5
MO4 + 10% LM	0.8	62.4	91.4	133.9	238.4
MO4 + 25% LM	7	77.5	111.9	151.6	262.7
MO4 + 50% LM	9.4	104.5	140.8	204.1	350.1
MO4 + 100% LM	34.6	151.1	199.4	269.6	443.9

Table 3-32. Quantiles of the Geometric Mean Abundance (across all years) for Salmon River East Fork Salmon

Alternative	2.5 Q	25 Q	50 Q	75 Q	97.5 Q
NAA	6.2	26.1	51.2	90.8	167.4
MO1	9.7	26.2	53.9	94.6	181.0
MO1 + 10% LM	9.8	36.0	66.0	110.3	185.5
MO1 + 25% LM	17.5	46.7	82.5	128.0	213.9
MO1 + 50% LM	24.5	64.6	110.0	169.2	276.7
MO1 + 100% LM	44.5	103.0	156.0	231.3	346.6
MO2	10.3	39.7	70.2	115.5	201.2
MO3.GRNIMN	2.7	11.8	27.2	57.2	129.0
MO3.GRNIMN + 10% LM	5.5	20.7	45.6	81.9	178.6
MO3.GRNIMN + 25% LM	13.9	46.7	90.6	146.3	229.6
MO3.GRNIMN + 50% LM	56.8	110.6	176.2	249.9	370.9
MO3.GRNIMN + 100% LM	198.7	306.4	398.1	504.7	700.1
MO3.SAL	15.1	50.2	88.4	149.4	242.5
MO3.SAL + 10% LM	30.0	76.2	134.6	192.8	311.9
MO3.SAL + 25% LM	69.6	126.2	193.5	283.7	423.3
MO3.SAL + 50% LM	133.9	243.1	330.3	448.3	618.1
MO3.SAL + 100% LM	333.7	494.3	628.3	765.5	1021.8
MO3.SNK	27.4	71.8	116.0	188.4	292.7
MO3.SNK + 10% LM	54.4	114.4	173.8	263.1	399.1
MO3.SNK + 25% LM	109.1	196.9	268.3	364.1	513.7
MO3.SNK + 50% LM	189.2	305.6	406.5	526.4	701.8
MO3.SNK + 100% LM	450.2	596.9	727.7	899.5	1182.5

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Alternative	2.5 Q	25 Q	50 Q	75 Q	97.5 Q
MO4	2.1	9.0	22.3	48.6	107.0
MO4 + 10% LM	4.0	17.3	38.5	75.4	134.7
MO4 + 25% LM	13.7	37.4	68.4	113.1	213.5
MO4 + 50% LM	25.1	85.7	135.6	202.5	335.2
MO4 + 100% LM	126.1	241.7	331.7	418.4	615.8

Table 3-33. Quantiles of the Geometric Mean Abundance (across all years) for Salmon River Lemhi

Alternative	2.5 Q	25 Q	50 Q	75 Q	97.5 Q
NAA	4.3	15.0	37.9	78.6	156.6
MO1	3.8	14.2	35.9	82.6	172.3
MO1 + 10% LM	5.0	19.4	46.8	89.3	202.4
MO1 + 25% LM	7.8	26.2	62.5	109.0	224.1
MO1 + 50% LM	9.4	39.8	87.6	148.5	255.3
MO1 + 100% LM	37.4	90.0	153.1	260.4	413.4
MO2	5.6	23.4	53.3	109.3	192.2
MO3.GRNIMN	1.9	5.5	15.0	37.4	106.3
MO3.GRNIMN + 10% LM	2.5	11.4	32.0	67.0	165.3
MO3.GRNIMN + 25% LM	9.3	31.7	77.9	135.2	255.8
MO3.GRNIMN + 50% LM	39.2	101.3	178.2	271.1	466.4
MO3.GRNIMN + 100% LM	184.6	328.9	479.3	611.5	1007.7
MO3.SAL	6.0	28.1	74.7	136.9	298.1
MO3.SAL + 10% LM	14.9	59.9	123.4	214.7	374.9
MO3.SAL + 25% LM	50.7	117.7	197.2	285.3	513.9
MO3.SAL + 50% LM	139.6	256.2	381.8	542.3	832.1
MO3.SAL + 100% LM	413.1	611.3	802.2	1019.9	1446.9
MO3.SNK	13.6	52.0	111.8	196.8	353.7
MO3.SNK + 10% LM	32.9	100.6	165.5	267.6	435.8
MO3.SNK + 25% LM	77.4	184.9	273.1	386.7	615.0
MO3.SNK + 50% LM	184.2	322.4	468.6	648.8	960.0
MO3.SNK + 100% LM	550.0	775.1	999.7	1246.0	1715.2
MO4	1.3	3.9	11.4	31.2	92.3
MO4 + 10% LM	2.3	10.3	26.3	60.2	128.2
MO4 + 25% LM	4.6	22.6	50.7	102.1	222.5
MO4 + 50% LM	18.3	72.1	128.6	221.4	355.6
MO4 + 100% LM	119.5	257.6	378.1	514.1	726.2

Table 3-34. Quantiles of the Geometric Mean Abundance (across all years) for Salmon River North Fork Salmon

Alternative	2.5 Q	25 Q	50 Q	75 Q	97.5 Q
NAA	2.4	6.6	13.9	25.1	50.8
MO1	2.4	6.4	15.6	28.7	54.7
MO1 + 10% LM	3.2	9.1	18.0	31.0	58.8

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Alternative	2.5 Q	25 Q	50 Q	75 Q	97.5 Q
MO1 + 25% LM	2.7	9.3	21.0	39.4	63.1
MO1 + 50% LM	4.1	14.0	26.4	45.2	84.7
MO1 + 100% LM	11.6	30.5	51.3	74.3	111.5
MO2	2.8	9.7	19.3	33.3	62.0
MO3.GRNIMN	1.3	2.9	6.8	14.4	31.5
MO3.GRNIMN + 10% LM	1.7	5.0	11.3	21.2	46.6
MO3.GRNIMN + 25% LM	3.7	12.9	24.7	40.9	81.7
MO3.GRNIMN + 50% LM	11.1	28.7	52.2	76.0	122.2
MO3.GRNIMN + 100% LM	52.8	93.7	134.6	174.0	239.4
MO3.SAL	3.6	13.5	24.0	42.3	81.7
MO3.SAL + 10% LM	6.8	20.7	37.6	60.4	104.4
MO3.SAL + 25% LM	14.1	39.6	63.3	92.6	144.7
MO3.SAL + 50% LM	43.7	84.5	117.9	156.1	216.7
MO3.SAL + 100% LM	125.9	173.8	220.5	278.9	360.0
MO3.SNK	6.2	19.2	37.3	61.2	96.3
MO3.SNK + 10% LM	12.8	31.2	50.3	75.9	123.1
MO3.SNK + 25% LM	28.8	60.0	85.0	119.0	167.7
MO3.SNK + 50% LM	58.8	103.3	138.0	183.5	242.0
MO3.SNK + 100% LM	153.8	208.8	269.6	333.5	430.7
MO4	1.2	2.6	5.9	11.5	29.2
MO4 + 10% LM	1.4	4.3	9.6	18.5	44.0
MO4 + 25% LM	2.2	7.8	18.8	33.3	61.4
MO4 + 50% LM	6.4	21.4	40.4	63.1	103.7
MO4 + 100% LM	34.1	73.8	103.6	136.4	210.2

Table 3-35. Quantiles of the Geometric Mean Abundance (across all years) for Salmon River Pahsimeroi

Alternative	2.5 Q	25 Q	50 Q	75 Q	97.5 Q
NAA	36.8	83.9	133.3	197.6	303.9
MO1	37.3	93.4	142.5	210.4	298.1
MO1 + 10% LM	41.8	95.1	151.0	222.0	328.3
MO1 + 25% LM	48.8	113.7	179.8	256.4	355.1
MO1 + 50% LM	70.8	152.6	225.5	295.6	406.9
MO1 + 100% LM	138.4	222.2	299.6	400.2	547.8
MO2	48.6	106.4	158.8	221.5	349.1
MO3.GRNIMN	11.9	34.9	76.9	129.0	233.2
MO3.GRNIMN + 10% LM	25.7	65.9	113.8	172.6	293.3
MO3.GRNIMN + 25% LM	58.0	119.8	192.1	261.1	409.2
MO3.GRNIMN + 50% LM	138.0	231.4	316.1	409.3	550.0
MO3.GRNIMN + 100% LM	327.2	501.3	633.1	791.3	998.8
MO3.SAL	53.9	118.4	192.1	273.9	409.7
MO3.SAL + 10% LM	89.6	178.2	247.9	341.2	493.9
MO3.SAL + 25% LM	149.1	271.0	367.2	473.5	676.3

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Alternative	2.5 Q	25 Q	50 Q	75 Q	97.5 Q
MO3.SAL + 50% LM	309.2	446.2	536.3	684.4	891.7
MO3.SAL + 100% LM	566.9	772.2	952.1	1153.0	1463.3
MO3.SNK	88.8	174.2	252.9	353.0	514.5
MO3.SNK + 10% LM	121.3	222.2	311.7	429.4	596.5
MO3.SNK + 25% LM	212.3	324.0	429.4	557.9	807.9
MO3.SNK + 50% LM	371.1	507.9	644.4	812.6	1086.3
MO3.SNK + 100% LM	707.9	935.5	1129.3	1326.8	1654.0
MO4	8.2	33.0	68.3	111.9	198.9
MO4 + 10% LM	11.8	49.6	96.1	147.4	266.4
MO4 + 25% LM	32.0	90.1	158.1	225.2	359.4
MO4 + 50% LM	95.0	183.7	280.2	373.4	525.9
MO4 + 100% LM	240.4	408.8	519.8	642.3	891.5

Table 3-36. Quantiles of the Geometric Mean Abundance (across all years) for Salmon River Panther Creek

Alternative	2.5 Q	25 Q	50 Q	75 Q	97.5 Q
NAA	5.1	15.2	28.5	42.6	73.9
MO1	5.5	17.4	29.0	45.1	74.2
MO1 + 10% LM	6.6	18.4	31.3	48.2	75.9
MO1 + 25% LM	8.9	24.5	39.5	60.4	87.9
MO1 + 50% LM	11.3	29.7	49.7	70.0	98.0
MO1 + 100% LM	22.4	47.5	69.8	93.0	127.9
MO2	7.7	19.9	33.6	56.0	81.9
MO3.GRNIMN	2.6	7.2	15.1	28.8	51.3
MO3.GRNIMN + 10% LM	4.9	13.7	25.0	38.4	67.7
MO3.GRNIMN + 25% LM	9.0	24.8	42.5	58.8	92.2
MO3.GRNIMN + 50% LM	29.6	51.8	74.2	95.7	146.5
MO3.GRNIMN + 100% LM	77.0	120.8	157.2	195.4	247.9
MO3.SAL	11.0	26.4	42.2	63.0	90.9
MO3.SAL + 10% LM	13.4	38.4	56.7	79.4	114.8
MO3.SAL + 25% LM	31.5	60.1	83.7	115.7	163.4
MO3.SAL + 50% LM	61.6	99.0	130.6	161.4	217.9
MO3.SAL + 100% LM	133.5	189.1	226.9	277.5	353.7
MO3.SNK	13.5	33.0	48.9	75.4	109.7
MO3.SNK + 10% LM	26.0	52.1	72.3	100.8	140.9
MO3.SNK + 25% LM	45.0	78.3	104.3	135.1	187.8
MO3.SNK + 50% LM	79.6	118.9	154.6	194.4	264.0
MO3.SNK + 100% LM	165.4	219.0	266.6	321.2	402.9
MO4	1.9	6.4	13.7	25.4	48.7
MO4 + 10% LM	2.6	9.1	18.7	31.9	58.3
MO4 + 25% LM	5.9	18.9	34.9	53.4	81.9
MO4 + 50% LM	16.8	44.5	64.2	85.9	125.2
MO4 + 100% LM	53.2	94.0	123.1	153.5	202.2

Table 3-37. Quantiles of the Geometric Mean Abundance (across all years) for Salmon River Upper Main

Alternative	2.5 Q	25 Q	50 Q	75 Q	97.5 Q
NAA	283.9	397.2	487.5	596.3	757.2
MO1	302.1	409.4	502.2	610.5	754.1
MO1 + 10% LM	303.7	427.6	516.8	615.7	775.5
MO1 + 25% LM	323.4	463.7	552.8	657.3	812.3
MO1 + 50% LM	382.5	508.7	627.1	741.7	924.6
MO1 + 100% LM	506.5	650.8	763.9	901.9	1075.4
MO2	315.8	427.2	517.7	624.3	754.6
MO3.GRNIMN	202.1	287.6	374.7	451.9	587.4
MO3.GRNIMN + 10% LM	261.5	367.5	451.6	562.6	742.1
MO3.GRNIMN + 25% LM	367.0	466.5	585.4	693.9	894.0
MO3.GRNIMN + 50% LM	504.9	657.0	788.7	910.4	1110.1
MO3.GRNIMN + 100% LM	802.1	996.6	1166.7	1354.0	1721.3
MO3.SAL	347.5	464.3	564.4	695.2	880.7
MO3.SAL + 10% LM	413.6	563.6	658.8	800.6	977.8
MO3.SAL + 25% LM	518.0	692.9	819.1	963.2	1207.4
MO3.SAL + 50% LM	730.2	899.4	1059.9	1245.9	1619.4
MO3.SAL + 100% LM	1140.6	1404.9	1608.1	1844.5	2231.3
MO3.SNK	443.6	544.4	654.4	777.8	988.9
MO3.SNK + 10% LM	495.9	630.7	744.6	884.1	1118.2
MO3.SNK + 25% LM	641.4	788.9	944.0	1121.5	1368.7
MO3.SNK + 50% LM	880.1	1032.7	1216.7	1443.0	1818.0
MO3.SNK + 100% LM	1273.5	1545.7	1776.7	2042.3	2516.6
MO4	174.2	274.6	353.4	430.0	579.3
MO4 + 10% LM	238.9	343.6	428.7	516.1	654.9
MO4 + 25% LM	298.4	431.1	521.1	633.0	787.3
MO4 + 50% LM	434.6	600.1	701.0	824.3	1025.0
MO4 + 100% LM	711.4	924.3	1064.0	1223.4	1489.3

Table 3-38. Quantiles of the Geometric Mean Abundance (across all years) for Salmon River Valley Creek

Alternative	2.5 Q	25 Q	50 Q	75 Q	97.5 Q
NAA	9.4	30.2	50.0	80.5	131.6
MO1	11.3	30.8	56.5	86.0	137.3
MO1 + 10% LM	11.5	33.8	57.7	85.4	141.1
MO1 + 25% LM	17.1	41.4	69.0	99.9	163.2
MO1 + 50% LM	20.3	54.2	84.0	116.7	183.4
MO1 + 100% LM	44.4	81.6	123.0	168.1	244.9
MO2	13.6	41.0	61.4	93.1	146.4
MO3.GRNIMN	4.2	14.0	29.7	52.1	92.8
MO3.GRNIMN + 10% LM	8.1	24.1	44.9	72.4	127.9

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Alternative	2.5 Q	25 Q	50 Q	75 Q	97.5 Q
MO3.GRNIMN + 25% LM	18.4	44.7	71.6	109.4	170.1
MO3.GRNIMN + 50% LM	53.7	98.2	141.9	190.0	270.5
MO3.GRNIMN + 100% LM	137.8	212.1	277.1	356.6	478.5
MO3.SAL	18.5	48.6	77.3	110.3	175.0
MO3.SAL + 10% LM	36.5	68.7	107.0	149.5	219.9
MO3.SAL + 25% LM	59.7	106.3	149.4	207.4	296.1
MO3.SAL + 50% LM	110.7	186.8	234.9	301.9	427.1
MO3.SAL + 100% LM	259.1	363.8	442.2	539.7	693.4
MO3.SNK	31.1	62.9	97.5	144.1	218.3
MO3.SNK + 10% LM	51.1	94.6	132.8	189.6	264.4
MO3.SNK + 25% LM	83.3	135.1	178.6	252.1	339.5
MO3.SNK + 50% LM	156.0	223.8	290.5	368.2	473.7
MO3.SNK + 100% LM	291.3	398.5	480.9	584.2	771.2
MO4	3.5	10.4	24.0	45.7	83.6
MO4 + 10% LM	4.6	20.9	39.1	62.7	113.1
MO4 + 25% LM	11.4	35.0	61.7	88.7	153.0
MO4 + 50% LM	25.6	71.4	111.5	149.6	234.8
MO4 + 100% LM	95.4	171.1	226.7	280.9	394.2

Table 3-39. Quantiles of the Geometric Mean Abundance (across all years) for Salmon River Yankee Fork Salmon

Alternative	2.5 Q	25 Q	50 Q	75 Q	97.5 Q
NAA	3.3	10.6	22.2	40.1	76.1
MO1	3.3	12.0	23.9	44.7	84.7
MO1 + 10% LM	3.6	14.0	27.7	51.9	86.8
MO1 + 25% LM	5.5	17.9	35.2	62.1	103.2
MO1 + 50% LM	9.1	25.6	45.5	75.0	121.1
MO1 + 100% LM	15.9	47.3	75.7	109.2	164.8
MO2	3.9	15.5	28.2	51.6	90.7
MO3.GRNIMN	1.7	4.6	10.0	22.6	53.3
MO3.GRNIMN + 10% LM	2.7	7.2	18.5	35.4	74.7
MO3.GRNIMN + 25% LM	6.6	20.8	38.8	60.5	106.6
MO3.GRNIMN + 50% LM	25.3	57.5	82.8	119.0	183.9
MO3.GRNIMN + 100% LM	86.7	140.6	187.5	239.9	336.6
MO3.SAL	5.5	19.9	41.9	72.0	121.3
MO3.SAL + 10% LM	10.4	34.9	61.5	95.6	156.0
MO3.SAL + 25% LM	21.9	59.7	92.7	134.2	210.7
MO3.SAL + 50% LM	67.3	119.0	161.2	217.6	293.4
MO3.SAL + 100% LM	165.8	244.5	301.4	381.1	493.4
MO3.SNK	12.3	33.0	56.0	92.3	151.3
MO3.SNK + 10% LM	25.3	52.3	82.9	119.6	202.5
MO3.SNK + 25% LM	42.4	85.6	120.4	162.2	239.3
MO3.SNK + 50% LM	79.1	148.1	194.6	257.6	354.5

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Alternative	2.5 Q	25 Q	50 Q	75 Q	97.5 Q
MO3.SNK + 100% LM	206.5	289.0	357.8	427.9	577.9
MO4	1.4	4.2	10.1	20.4	52.4
MO4 + 10% LM	2.0	6.6	15.4	30.8	65.1
MO4 + 25% LM	4.7	14.7	29.2	50.6	91.4
MO4 + 50% LM	10.3	36.7	64.1	98.8	162.9
MO4 + 100% LM	58.9	106.8	151.1	197.1	273.2

CSS Adult Metric Results

Table 3-40. Predicted Adult Fish Ocean Survival Rates with No Surface Passage (0%), 10 %, 20%, and 30% Surface Passage Efficiencies using the Cohort-Specific Model

Alternative by Species	NAA 0%	MO1 0%	MO1 10%	MO1 20%	MO1 30%	MO2 0%	MO2 10%	MO2 20%	MO2 30%	MO3 0%	MO3 10%	MO3 20%	MO3 30%	MO4 0%	MO4 10%	MO4 20%	MO4 30%
Yearling Chinook	0.036	0.038	0.039	0.039	0.039	0.025	0.026	0.027	0.028	0.059	0.059	0.059	0.060	0.055	0.056	0.056	0.057

Table 3-41. Predicted SARs with no surface passage (0%), 10%, 20%, and 30% surface passage efficiencies using Life-Cycle Model

Alternative / Population Percentage	NAA 0%	MO1 0%	MO1 10%	MO1 20%	MO1 30%	MO2 0%	MO2 10%	MO2 20%	MO2 30%	MO3 0%	MO3 10%	MO3 20%	MO3 30%	MO4 0%	MO4 10%	MO4 20%	MO4 30%
CC	0.027	0.028	0.028	0.028	0.028	0.018	0.018	0.019	0.019	0.049	0.049	0.049	0.049	0.044	0.044	0.044	0.045
GR	0.028	0.028	0.028	0.028	0.028	0.018	0.018	0.019	0.019	0.049	0.049	0.050	0.050	0.043	0.044	0.044	0.045
IMN	0.028	0.028	0.028	0.028	0.028	0.018	0.018	0.019	0.019	0.049	0.050	0.050	0.050	0.044	0.044	0.044	0.045
LOS	0.028	0.028	0.028	0.028	0.029	0.018	0.018	0.019	0.019	0.049	0.050	0.050	0.050	0.044	0.044	0.045	0.045
MIN	0.028	0.028	0.028	0.028	0.028	0.018	0.018	0.019	0.019	0.049	0.050	0.050	0.050	0.044	0.044	0.045	0.045
WEN	0.028	0.028	0.028	0.028	0.028	0.018	0.018	0.019	0.019	0.049	0.049	0.050	0.050	0.044	0.044	0.044	0.045

Table 3-42. Performance of SARs relative to the NAA , with no surface passage (0%), 10%, 20%, and 30% surface passage efficiencies using Life-Cycle Model. Values greater than 1 indicate the relative increase over the NAA

Alternative / Population	MO1 0%	MO1 10%	MO1 20%	MO1 30%	MO2 0%	MO2 10%	MO2 20%	MO2 30%	MO3 0%	MO3 10%	MO3 20%	MO3 30%	MO4 0%	MO4 10%	MO4 20%	MO4 30%
CC	1.01	1.02	1.03	1.03	0.64	0.66	0.68	0.70	1.77	1.78	1.79	1.80	1.59	1.60	1.61	1.62
GR	1.01	1.02	1.02	1.03	0.64	0.66	0.68	0.70	1.77	1.78	1.79	1.80	1.57	1.58	1.60	1.61
IMN	1.01	1.02	1.03	1.03	0.64	0.66	0.68	0.70	1.79	1.80	1.81	1.81	1.58	1.59	1.61	1.62
LOS	1.01	1.02	1.02	1.03	0.64	0.65	0.67	0.69	1.77	1.78	1.79	1.79	1.57	1.59	1.60	1.62
MIN	1.01	1.01	1.02	1.03	0.64	0.65	0.67	0.69	1.79	1.80	1.81	1.82	1.59	1.60	1.61	1.63
WEN	1.01	1.01	1.02	1.03	0.64	0.66	0.67	0.69	1.78	1.79	1.79	1.80	1.57	1.59	1.60	1.61

Table 3-43. Predicted abundances with no surface passage (0%), 10%, 20%, and 30% surface passage efficiencies using Life-Cycle Model

Alternative / Population Percentage	NAA 0%	MO1 0%	MO1 10%	MO1 20%	MO1 30%	MO2 0%	MO2 10%	MO2 20%	MO2 30%	MO3 0%	MO3 10%	MO3 20%	MO3 30%	MO4 0%	MO4 10%	MO4 20%	MO4 30%
CC	232	237	239	244	246	103	109	122	128	548	551	560	561	450	456	464	470
GR	258	266	278	286	289	91	99	119	128	739	743	764	766	600	609	625	633
IMN	2549	2577	2587	2626	2649	1395	1446	1519	1573	5297	5315	5325	5351	4537	4591	4648	4696
LOS	742	763	764	780	787	374	391	417	436	1650	1656	1658	1665	1391	1409	1426	1442
MIN	1140	1162	1169	1184	1196	621	647	676	705	2385	2394	2403	2416	2054	2077	2102	2126
WEN	1193	1205	1226	1243	1261	442	469	504	538	3241	3265	3287	3306	2662	2701	2745	2792

Table 3-44. Abundances relative to the NAA, with no surface passage (0%), 10%, 20%, and 30% surface passage efficiencies using Life-Cycle Model. Values greater than 1 indicate the relative increase over the NAA

Alternative / Population Percentage	MO1 0%	MO1 10%	MO1 20%	MO1 30%	MO2 0%	MO2 10%	MO2 20%	MO2 30%	MO3 0%	MO3 10%	MO3 20%	MO3 30%	MO4 0%	MO4 10%	MO4 20%	MO4 30%
CC	1.02	1.03	1.05	1.06	0.45	0.47	0.53	0.55	2.37	2.38	2.42	2.42	1.94	1.97	2.00	2.03
GR	1.03	1.08	1.11	1.12	0.35	0.38	0.46	0.50	2.87	2.88	2.97	2.97	2.33	2.37	2.43	2.46
IMN	1.01	1.01	1.03	1.04	0.55	0.57	0.60	0.62	2.08	2.09	2.09	2.10	1.78	1.80	1.82	1.84
LOS	1.03	1.03	1.05	1.06	0.50	0.53	0.56	0.59	2.22	2.23	2.23	2.24	1.87	1.90	1.92	1.94
MIN	1.02	1.03	1.04	1.05	0.55	0.57	0.59	0.62	2.09	2.10	2.11	2.12	1.80	1.82	1.84	1.87
WEN	1.01	1.03	1.04	1.06	0.37	0.39	0.42	0.45	2.72	2.74	2.76	2.77	2.23	2.26	2.30	2.34

Table 3-45. Predicted Transport: In-river Ratios (TIRs) with no surface passage (0%), 10%, 20%, and 30% surface passage efficiencies. No transportation would occur under MO3

Alternative by Species	NAA 0%	MO1 0%	MO1 10%	MO1 20%	MO1 30%	MO2 0%	MO2 10%	MO2 20%	MO2 30%	MO3 0%	MO3 10%	MO3 20%	MO3 30%	MO4 0%	MO4 10%	MO4 20%	MO4 30%
Wild Yearling Chinook	0.86	0.69	0.69	0.68	0.68	1.29	1.26	1.22	1.18	NA	NA	NA	NA	0.58	0.57	0.56	0.56

3.6.4.1 TDG Tool Results

3.6.5 Snake River Spring Chinook

Table 3-46. Mean Reach Average Exposure (RAE) results for Snake River juvenile Spring Chinook in both Allriver (LWG-BON) and Lower Columbia (MCN – BON) reaches, under the different alternatives.

Alternative	RAE (%) for Allriver (LWG-BON)	RAE (%) for Lower Columbia (MCN-BON)
NAA	115.1	115.4
MO1	115.5	115.6
MO2	112.8	112.3
MO3.SAL	109.2	116.6
MO3.GRNIMN	109.3	116.8
MO3.SNK	109.2	116.6
MO4	119.6	119.2

Note: The Allriver model run used transportation rules, whereas the Lower Columbia run did not.

Table 3-47. Mean survival results for Snake River juvenile Spring Chinook in both Allriver (LWG-BON) and Lower Columbia (MCN – BON) reaches, under the different alternatives. The Allriver model run used transportation rules, whereas the Lower Columbia run did not.

Alternative	Survival (%) for Allriver (LWG-BON)	Survival (%) for Lower Columbia (MCN-BON)
NAA	97.3	98.4
MO1	96.9	98.5
MO2	98.7	99.2
MO3.SAL	97.7	97.7
MO3.GRNIMN	97.8	97.8
MO3.SNK	97.7	97.7
MO4	82.8	95.7

Table 3-48. Counts of years when Reach Average Exposure (RAE) is greater than, or equal to 120% for Snake River juvenile Spring Chinook in both Allriver (LWG-BON) and Lower Columbia (MCN – BON) reaches, under the different alternatives.

Alternative	Counts of years when RAE is >= 120% for Allriver (LWG-BON)	Counts of years when RAE is >= 120% for Lower Columbia (MCN-BON)
NAA	1	3
MO1	1	2
MO2	1	1
MO3.SAL	0	1
MO3.GRNIMN	0	2
MO3.SNK	0	1
MO4	36	28

Note: The Allriver model run used transportation rules, whereas the Lower Columbia run did not.

3.6.6 Snake River Steelhead

3.6.6.1 COMPASS Results

Table 3-49. Summary results for Snake River Steelhead by Alternative

Alternative	Mean Survival	95% CI Survival	Mean Arrival at BON	Proportion Destined for Transport	Mean Gas Exposure	Proportion Powerhouse Passage	Mean Travel time (LGR-MCN) (Days)	Mean Travel time (MCN-BON) (Days)	Mean Migration Rate (LGR-MCN) (mi/day)	Mean Migration Rate (MCN-BON) (mi/day)	Mean Temp Experience (Snake)	Mean Temp Experience (Columbia)	Mean Flow Experience (Snake)	Mean Flow Experience (Columbia)	Mean Gas Experience (Snake)	Mean Gas Experience (Columbia)	Avg. Num Bypasses	Avg. Num Turbine Passages	Avg. Num Spill Passages
NAA	0.4271	0.3682-0.4821	133.19	0.3968	114.71	0.216	9.65	6.74	13.23	26.64	11.31	13.26	91.52	270.71	112.03	115.07	1.29	0.44	6.27
MO1	0.4224	0.3631-0.4778	133.46	0.3908	114.91	0.184	9.60	6.78	13.27	26.42	11.32	13.33	91.82	266.06	112.42	115.22	1.07	0.41	6.53
MO2	0.4016	0.3591-0.4391	131.63	0.4773	112.71	0.282	10.03	6.88	12.84	26.10	11.20	13.14	90.70	265.44	110.65	112.00	1.12	1.13	5.74
MO3-GRNIMN-WH	0.5107	0.4250-0.5913	141.15	0.0000	111.87	0.109	8.94	6.27	11.06	28.43	12.00	14.20	95.04	279.55	101.11	117.48	0.17	0.27	3.56
MO3-SAL-WH	0.5268	0.4555-0.5930	134.25	0.0000	111.54	0.105	4.21	6.88	20.86	26.38	11.37	13.13	91.96	264.85	101.03	116.99	0.16	0.26	3.58
MO3-SAL-W	0.5263	Not Estimated	134.26	0.0000	111.54	0.107	4.21	6.88	20.86	26.38	11.37	13.13	91.96	264.85	101.03	116.99	0.16	0.27	3.57
MO3-SNK-WH	0.5646	0.4890-0.6277	131.73	0.0000	111.32	0.110	1.81	7.19	47.34	25.49	11.15	12.74	90.39	258.77	100.99	116.63	0.16	0.28	3.56
MO4	0.4314	0.3676-0.4895	138.17	0.0719	118.26	0.043	8.71	6.35	14.37	27.97	11.58	13.72	94.74	281.85	116.24	118.74	0.21	0.13	7.65

3.6.6.2 CSS Juvenile Metrics Results

Table 3-50. Predicted SR Steelhead juvenile survival (LGR-BON) with no surface passage (0%), 10%, 20%, and 30% surface passage efficiencies using the cohort-specific model

Alternative and Passage Efficiency	NAA 0%	MO1 0%	MO1 10%	MO1 20%	MO1 30%	MO2 0%	MO2 10%	MO2 20%	MO2 30%	MO3 0%	MO3 10%	MO3 20%	MO3 30%	MO4 0%	MO4 10%	MO4 20%	MO4 30%
Mean survival	0.571	0.578	0.581	0.585	0.588	0.394	0.411	0.427	0.444	0.829	0.830	0.830	0.831	0.729	0.732	0.734	0.737
25%-75% inter-quartile range	0.455-0.700	0.463-0.707	0.467-0.710	0.471-0.713	0.475-0.716	0.251-0.525	0.266-0.545	0.283-0.565	0.299-0.585	0.777-0.904	0.778-0.904	0.779-0.905	0.780-0.905	0.647-0.844	0.651-0.846	0.654-0.848	0.657-0.850

Table 3-51. Predicted SR Steelhead Juvenile Travel Times (LGR-BON) with No Surface Passage (0%), 10%, 20%, and 30% Surface Passage Efficiencies Using the Cohort-Specific Model

Alternative by Passage Efficiency	NAA 0%	MO1 0%	MO1 10%	MO1 20%	MO1 30%	MO2 0%	MO2 10%	MO2 20%	MO2 30%	MO3 0%	MO3 10%	MO3 20%	MO3 30%	MO4 0%	MO4 10%	MO4 20%	MO4 30%
Mean Travel Time	16.2	16.3	16.3	16.2	16.2	17.6	17.5	17.4	17.2	11.0	11.0	11.0	11.0	14.7	14.7	14.6	14.6
25%-75% inter-quartile range	11.7-18.6	11.8-18.7	11.8-18.7	11.8-18.7	11.7-18.6	12.5-20.6	12.4-20.4	12.4-20.3	12.3-20.1	8.7-12.6	8.7-12.6	8.7-12.6	8.6-12.6	10.7-16.9	10.7-16.9	10.7-16.9	10.7-16.9

Table 3-52. Mean Seasonal Average PITPH (95% Confidence Interval) for Spring/Summer Steelhead Over the 80-Year Water Record for Each CRSO EIS Alternative Used in the CSS Modeling

Species	EIS Alternative	No PHSP	PSP–10% Efficiency	PSP–20% Efficiency	PSP–30% Efficiency
Steelhead	NAA	1.96 (1.85-2.06)	–	–	–
Steelhead	MO1	1.69 (1.56-1.83)	1.68 (1.54-1.81)	1.66 (1.53-1.79)	1.64 (1.51-1.77)
Steelhead	MO2	3.65 (3.55-3.75)	3.52 (3.43-3.62)	3.39 (3.3-3.48)	3.26 (3.18-3.35)
Steelhead	MO3	0.47 (0.42-0.52)	0.47 (0.42-0.52)	0.46 (0.41-0.51)	0.46 (0.41-0.51)
Steelhead	MO4	0.36 (0.31-0.42)	0.34 (0.29-0.39)	0.31 (0.26-0.36)	0.28 (0.24-0.32)

Notes: ^A There are no PSP structures in the NAA. Therefore, the CSS did not estimate PITPH under the 10%, 20%, and 30% efficiencies for this alternative.

PSP refers to the addition of Powerhouse Surface Passage structures, with assumed 10%, 20% and 30% efficiencies.

3.6.6.3 CSS Adult Metrics Results

Table 3-53. Predicted Snake River Steelhead Adult Fish Ocean Survival Rates with No Surface Passage (0%), 10%, 20%, and 30% Surface Passage Efficiencies using the Cohort-Specific Model.

Alternative by Species	NAA 0%	MO1 0%	MO1 10%	MO1 20%	MO1 30%	MO2 0%	MO2 10%	MO2 20%	MO2 30%	MO3 0%	MO3 10%	MO3 20%	MO3 30%	MO4 0%	MO4 10%	MO4 20%	MO4 30%
Mean ocean survival	0.036	0.037	0.037	0.037	0.037	0.024	0.024	0.025	0.025	0.046	0.046	0.046	0.046	0.042	0.042	0.042	0.042
25%-75% inter-quartile range	0.016-0.044	0.016-0.045	0.016 0.045	0.016-0.045	0.016-0.045	0.014-0.039	0.014-0.039	0.014-0.040	0.014 - 0.040)	0.020-0.057	0.020-0.057	0.020-0.057	0.020-0.057	0.018-0.052	0.018-0.052	0.018-0.052	0.018-0.052

Table 3-54. Predicted Snake River Steelhead SARs with no surface passage (0%), 10%, 20%, and 30% surface passage efficiencies using the cohort-specific model.

Alternative by Species	NAA 0%	MO1 0%	MO1 10%	MO1 20%	MO1 30%	MO2 0%	MO2 10%	MO2 20%	MO2 30%	MO3 0%	MO3 10%	MO3 20%	MO3 30%	MO4 0%	MO4 10%	MO4 20%	MO4 30%
SAR	0.018	0.018	0.019	0.019	0.019	0.012	0.012	0.013	0.013	0.050	0.050	0.050	0.050	0.030	0.031	0.031	0.031
25%-75% inter-quartile range	0.005-0.022	0.005-0.022	0.006-0.022	0.006-0.022	0.006-0.022	0.003-0.013	0.003-0.014	0.003-0.015	0.004-0.016	0.016-0.061	0.016-0.061	0.016-0.061	0.016-0.061	0.009-0.036	0.009-0.037	0.009-0.037	0.009-0.037

Table 3-55. Predicted Snake River Steelhead Transport: In-river Ratios (TIRs) with no surface passage (0%), 10%, 20%, and 30% surface passage efficiencies.

Alternative by Species	NAA 0%	MO1 0%	MO1 10%	MO1 20%	MO1 30%	MO2 0%	MO2 10%	MO2 20%	MO2 30%	MO3 0%	MO3 10%	MO3 20%	MO3 30%	MO4 0%	MO4 10%	MO4 20%	MO4 30%
TIR	1.41	1.09	1.10	1.07	1.08	2.51	2.41	2.32	2.23	NA	NA	NA	NA	0.82	0.82	0.80	0.79
25%-75% inter-quartile range	0.69-1.77	0.53-1.37	0.54-1.37	0.53-1.34	0.52-1.36	1.23-3.16	1.19-3.02	1.13-2.89	1.09-2.80	NA	NA	NA	NA	0.40-1.04	0.40-1.03	0.39-1.00	0.38-0.99

Note: No transportation would occur under MO3.

3.6.6.4 TDG Tool Results

Table 3-56. Mean Reach Average Exposure (RAE) results for Snake River juvenile Steelhead in both Allriver (LWG-BON) and Lower Columbia (MCN – BON) reaches, under the different alternatives. The Allriver model run used transportation rules, whereas the Lower Columbia run did not.

Alternative	RAE (%) for Allriver (LWG-BON)	RAE (%) for Lower Columbia (MCN-BON)
NAA	115.1	115.3
MO1	115.5	115.6
MO2	112.7	112.1
MO3.SAL	109.2	116.6
MO3.GRNIMN	109.4	116.9
MO3.SNK	109	116.3
MO4	119.8	119.3

Table 3-57. Mean survival results for Snake River juvenile Steelhead in both Allriver (LWG-BON) and Lower Columbia (MCN – BON) reaches, under the different alternatives. The Allriver model run used transportation rules, whereas the Lower Columbia run did not.

Alternative	Survival (%) for Allriver (LWG-BON)	Survival (%) for Lower Columbia (MCN-BON)
NAA	97.3	94.6
MO1	97.3	94
MO2	98.4	96.9
MO3.SAL	96.6	96.5
MO3.GRNIMN	96.6	96.5
MO3.SNK	96.6	96.6
MO4	94.7	78

Table 3-58. Counts of years when Reach Average Exposure (RAE) is greater than, or equal to 120% for Snake River juvenile Steelhead in both Allriver (LWG-BON) and Lower Columbia (MCN – BON) reaches, under the different alternatives. The Allriver model run used transportation rules, whereas the Lower Columbia run did not.

Alternative	Counts of years when RAE is >= 120% for Allriver (LWG-BON)	Counts of years when RAE is >= 120% for Lower Columbia (MCN-BON)
NAA	1	2
MO1	2	2
MO2	0	0
MO3.SAL	0	2
MO3.GRNIMN	0	2
MO3.SNK	0	1
MO4	37	25

3.6.7 Snake River Coho Salmon

Table 3-59. Snake River Coho Salmon Qualitative Effects Analysis Matrix

Affected Environment Important Relationships/Criteria	Affected Environment Metric	Environmental Consequences NAA	Environmental Consequences MO1	Environmental Consequences MO2	Environmental Consequences MO3	Environmental Consequences MO4	Notes
Juvenile passage at the four lower Columbia River dams and four lower Snake River dams affects dam-specific and in-river survival rate of juvenile Snake River coho salmon.	Juvenile Snake River spring Chinook salmon as surrogate for juvenile Snake River coho response for this metric. Use direct estimate of in-river survival for Snake River coho No Action Alternative. Estimate change in in-river survival (e.g., MO1-NAA/NAA) for juvenile Snake River spring Chinook as surrogate for coho using COMPASS and CSS in-river survival estimates. ¹	2007-2017 LGR to MCN average Snake River coho in-river survival (95% lower and upper confidence intervals) from Widener et al. (2019) analysis: 79% (71% to 87%) 2007 to 2017 LGR to BON average in-river survival for Snake River PIT-tagged coho (95% lower and upper confidence intervals): 68%	See change in Snake River spring/summer Chinook salmon downstream passage.	See change in Snake River spring/summer Chinook salmon downstream passage.	See change in Snake River spring/summer Chinook salmon downstream passage.	See change in Snake River spring/summer Chinook salmon downstream passage.	Dan Widener (2019). Apply change in COMPASS and CSS in-river survival for juvenile spring Chinook salmon as qualitative surrogate for Snake River coho salmon.
Predation in reservoirs – changes in the LGR to BON reservoir environments (relative to the NAA) may change the susceptibility of Snake River juvenile coho salmon to avian and piscine predators.	Susceptibility of juvenile coho to predators (avian and piscine) in reservoirs. The fish team will also evaluate measures that affect the predation rate. Change in piscine predator activity is captured at least in part by COMPASS in-river survival response (juvenile Snake River spring Chinook) above and does not need duplication or double counting here. Metrics: 1) Change in proportion turbine passage (an increase may signify higher susceptibility to predation); 2) Improved fish passage (IFP) turbines (this measure should pass fish with less impact than non-IFP turbines); and 3) Change in travel time (an increase may signify higher susceptibility to predation).	1) 0.82 average turbine passages for Snake River spring Chinook salmon from LGR to BON (COMPASS). 2) IFP turbines at IHR and MCN, not JDA. 3) Travel time 17.7 days juvenile Snake River spring Chinook salmon average travel time from LGR to BON (COMPASS).	1) and 3) See change in Snake River spring/summer Chinook downstream passage. 2) IFP turbines from NAA, also JDA.	1) and 3) See change in Snake River spring/summer Chinook downstream passage. 2) IFP turbines from NAA, also JDA.	1) and 3) See change in Snake River spring/summer Chinook downstream passage. 2) IFP turbines from NAA, also JDA.	1) and 3) See change in Snake River spring/summer Chinook downstream passage. 2) IFP turbines from NAA, also JDA.	CP: Using spring Chinook salmon as the surrogate, the team can consider active tag survival tests showing outcome by route – could the team cite the whole set of these? Steelhead have the highest avian predation, followed by CH1, than CH0. We may presume that most mortality of smolts through a route is due to predation rather than direct mortality. Most dams have small to moderately lower immediate survival for turbine passage (with route fraction from 2% to 17% for dams except BON). Of note, BON has the highest turbine route fraction of 8 dams (29% in 2011) and slightly higher survival than the spillway (~96%). For travel time, the acoustic tag tests typically report cohort tailrace egress time rather than by route.
Adult upstream passage at the four lower Columbia River dams and four lower Snake River dams affects in-river survival rate of juvenile Snake River coho salmon.	Use adult Snake River fall Chinook salmon passage analysis as proxy for adult coho passage considerations. ²	BON to LGR adult Snake River fall Chinook salmon average survival 80.4% to 88.8% (depending on whether migrated in-river or were transported as juveniles) estimate from 2019 CRS BiOp, page 853.	See change in fall Chinook salmon upstream passage for MO1.	See change in fall Chinook salmon upstream passage for MO2.	See change in fall Chinook salmon upstream passage for MO3.	See change in fall Chinook salmon upstream passage for MO4.	2019 CRS BiOp, page 853.

¹Coho-specific dam survival measurements are not available, but coho-specific in-river survival estimates are available for current system conditions. There are no coho-specific models available to predict changes in these metrics from CRS alternatives. However, survival models that project changes in these metrics based on changes in hydrosystem operation and configurations are available for spring Chinook salmon and steelhead (COMPASS, CSS). Coho salmon outmigration timing generally overlaps with both spring Chinook salmon and steelhead, and all three species have dominant stream-type life histories. However, the size of juvenile coho and juvenile spring Chinook salmon tend to be more closely aligned than juvenile steelhead. Therefore, juvenile spring Chinook salmon will be considered the appropriate surrogate for juvenile coho salmon for purposes of qualitative effects analysis of changes in passage. This use of juvenile Snake River spring Chinook salmon as a surrogate for juvenile lower Columbia River coho salmon is consistent with the 2008 FCRSP BiOp, 2013 Recovery Plan, and 2019 CRS BiOp.

²Dam survival and reach survival measurements specific to adult coho are not available for the previous 10-year period. Adult Coho salmon upstream migration timing general overlaps with fall Chinook salmon, through fall Chinook salmon migration timing tends to start earlier in some years (DART). Far more adult fall Chinook salmon enter the CRS system than Coho salmon adults, so survival estimates generally have higher certainty for the former than the latter. Adult fall Chinook salmon will be considered the appropriate surrogate for adult coho salmon for purpose of qualitative effects analysis of changes in passage. This use of adult Snake River fall Chinook salmon as a surrogate for adult lower Columbia River coho salmon is consistent with the 2008 FCRPS BiOp, 2013 Recovery Plan, and 2019 CRS BiOp.

NOTE ABOUT OCEAN SURVIVAL: The CSS (2017) makes no prediction in terms of survival benefits for lower Columbia River, upper Columbia River, or lower Snake River coho salmon. The CSS predicts that increased spill could substantially reduce latent mortality of juvenile yearling Chinook salmon and steelhead moving downstream through the mainstem dams. If this were to occur for coho salmon, SARs would also be improved for the XX populations that pass above XX dams and migrate during the spring, and the potential benefit would generally be less than what may occur for species that experience passage through a greater number of Columbia and Snake River mainstem dams (NMFS, 2019). The COMPASS and LCM models do not ascribe latent effects to specific routes of passage, but the NWFSC considered four latent mortality reduction scenarios that were estimated to represent the ranges of potential outcomes (increased productivity) indicated by the CSS (2017) for the CRSO alternatives compared to the CRSO No Action Alternative spill operations.

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3.6.8 Snake River Sockeye Salmon

Table 3-60. Snake River Sockeye Salmon Qualitative Effects Analysis Matrix

Affected Environment Important Relationships/Criteria	Affected Environment Metric	Environmental Consequences NAA	Environmental Consequences MO1	Environmental Consequences MO2	Environmental Consequences MO3	Environmental Consequences MO4	Notes
Juvenile Mainstem Passage							
Juvenile travel time affects juvenile survival.	Downstream Travel Time Fish modeling travel time changes for juvenile spring Chinook as surrogate for change in juvenile sockeye travel time. COMPASS and CSS travel times are for in-river fish only. Transported travel times are faster still.	Avg. travel time 17.71 days for juvenile Chinook (COMPASS: LWG-BON) Note: no confidence intervals calculated for juvenile chinook travel time. While sockeye are slightly smaller than their surrogate (Chinook) they generally have shorter travel times. These data should be used for relative differences in alternatives Under the NAA Snake River sockeye will likely experience a travel time slightly shorter than 17.71 days.	Negligible decrease. (17.37 days - 8 hours shorter) Negligible decrease in travel time under MO1	Minor increase. (18.34 days - 15 hours longer) Assume minor increase in travel times and poorer survival under MO2	Decrease. (12.15 days - 5.5 days shorter) Assume a Major reduction in travel time. Assume better survival under MO3	Decrease. (16.18 days - 36 hours shorter) Assume minor decrease in travel times and better survival under MO4	Smolt survival is inversely related to travel time. Question: why not just use in-river chinook survival as a surrogate for sockeye? Used spring Chinook. Use Faulkner report for current travel times as well. Sockeye travel times are usually much faster than Chinook travel time. Note: no confidence intervals calculated for juvenile Chinook travel time.
Transport as juveniles is associated with lower adult survival in the BON to MCN reach (Crozier et al., 2018). However, juvenile transport is also associated with higher juvenile survival.	% of juvenile sockeye transported	% of fish transported: 39.0% of juvenile Chinook are destined for transport. Assume a similar percent of Sockeye would also be transported	% of fish transported: 38% Note: no confidence intervals calculated for juvenile chinook destined for transport. No change from NAA	% of fish transported: 47% Note: no confidence intervals calculated for juvenile chinook destined for transport. 8% increase in transport. These fish will have minor increase in initial survival rates, and minor increases in straying.	% of fish transported: No Transport Under this alternative fish will have moderate increases in juvenile survival and adult returns.	% of fish transported: 7% Note: no confidence intervals calculated for juvenile chinook destined for transport. Assume minor decreases in juvenile survival and adult straying.	Use COMPASS for proportion transported (Chinook as surrogate for this metric)? Check relationship for survival in transport. CSS annual report does bypass and transport comparison. Larger hatchery smolts benefited most from transport, while smaller natural smolts did not benefit. Use sockeye data from 2011 to set expectations for surrogate. Suggest deleting this relationship as it is not certain the overall effect of transport on survival.

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Affected Environment Important Relationships/Criteria	Affected Environment Metric	Environmental Consequences NAA	Environmental Consequences MO1	Environmental Consequences MO2	Environmental Consequences MO3	Environmental Consequences MO4	Notes
Spill affects juvenile migration routes through the projects. Increased spill generally reduces travel time as fish find spill routes more readily than turbine routes. More spill generally means fewer powerhouse encounters.	In-river survival from COMPASS Modeling - use spring/summer Chinook as surrogate. Add Powerhouse encounter rate as well.	In-river survival average: 50.4% (95% CI: 45.7%-54.4) for juvenile chinook COMPASS: Prop Power house = 0.28 Under the NAA SR sockeye will continue to survive at the approximately the same levels as shown in the recent years. Power house encounter will also continue at approximately the same rate.	In-river survival average: 51.0% (95% CI: 46.2-55.2%) Prop Power house = 0.24 Negligible Increase, but not a statistically significant change. No difference from NAA.	In-river survival average: 50.1% (95% CI: 46.2-53.4%) Prop Power house = 0.38 Negligible Increase, but not a statistically significant change Higher proportion of powerhouse but no difference from NAA survival.	In-river survival average: 60.0% (95% CI: 54.8-64.6%) Prop Power house = 0.17 Significant difference from NAA survival. Moderate increase in survival and moderate decrease in powerhouse encounter.	In-river survival average: 50.7% (95% CI: 46.0-54.9%) Prop Power house = 0.06 Significant reduction in Power House Encounter did not equate to significant change in survival = because transported fish survive at 98%. No change in survival, Major change in powerhouse encounters.	While Chinook was used as a surrogate for sockeye, the smaller size of sockeye makes it unlikely they survive as well as Chinook. Assume survival is slightly lower. Relative survivals should be used to determine impacts from alternatives. Check to see if survival for in-river only differs from In-river and transported. Consider using both in the analysis. Note: no confidence intervals calculated for juvenile Chinook travel time. Can use actual Sockeye data to compare with Surrogate data.
Predation in reservoirs – changes in the reservoir environment (relative to the NAA) may change the susceptibility of juvenile sockeye to avian and piscine predators.	Risk of predation to piscine predators. Use temperature during outmigration (April-June at IHR) as a surrogate for piscine predation. Use habitat increase or decrease for Avian Predators	Mean Water temperature April - June under NAA is 13.03°C degrees. No change from current. Under the NAA an unknown number of juvenile sockeye will be removed from the population by piscine predators. Literature estimates that smallmouth bass, Walleye, and NPM remove large numbers of smolts. Erhardt et al. (2018) and Tiffen et al. (2018) found that SMB consumed over 300,000 sub adult Chinook in a 22-km study reach.	Mean Water temperature April - June under NAA is 13.03C degrees (1.5 degree SD). No change from NAA JDA operations in MO1 will raise water elevations to prevent Avian nesting and reduce risk of predation from avian predators.	Mean Water temperature April - June under NAA is 13.00°C (1.6 degree SD). No change from NAA.	Under MO3, large numbers of predators will be eliminated because of high sediment and low dissolved oxygen concentrations during dam breaching. SMB are expected to return to pre-breaching densities. We expect long term reductions in Walleye, and other lentic species. In addition, water travel time will decrease dramatically reducing exposure to SR predators. Overall, there will be a major decrease in risk to piscine predation at the time of breaching followed by gradual increases in risk of exposure to these predators. Turbidity is expected to increase and will reduce predation risk as well.	Mean Water temperature April - June under NAA is 13.03°C (3.3 degree SD). No change from NAA. MOP operations at projects may increase nesting habitat and risk of avian predation.	Oregon looks at predation in terms of abundance x rate of predation. If measure is likely to change either abundance or rate, then assume changing. Then compensatory or additive. No abundance data. See Fall Chinook matrix for general relationships for Piscine Predators Avian predation reduced for Sockeye relative to steelhead. Size selectivity. Note: change in piscine predator activity is captured at least in part by COMPASS (juvenile Chinook) in-river survival response above, specifically the temperature relationship.

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Affected Environment Important Relationships/Criteria	Affected Environment Metric	Environmental Consequences NAA	Environmental Consequences MO1	Environmental Consequences MO2	Environmental Consequences MO3	Environmental Consequences MO4	Notes
Avian predation – avian nesting habitat increases or decreases.	Increase or decrease in avian nesting habitat.	Avian nesting habitat and risk to avian predators is expected to have minor decreases under ongoing avian management plans under NAA.	Reduced nesting habitat relative to the NAA will likely reduce avian predation risk under MO1 - a result of JDA pool operations to dissuade nesting at Blalock. Earlier migrants (steelhead and Sockeye) are more impacted.	No change from NAA	Increase in nesting habitat expected in lower Ice Harbor pool. Only those islands that would not be inundated in spring flows and are suitable habitat. Potential increase in risk from added nesting habitat would likely be offset by significant decreases in travel times - reducing exposure to avian predators. (see travel times under MO3).	No change from NAA	Islands in free-flowing Snake River do not have avian colonies. Would they use the lower Snake? Get information from avian team to discuss potential use of snake river islands. Note: Wildlife team is assessing change in habitat opportunity for avian predators. Resident fish team is assessing change in piscine predators.
Adult Passage							
Juvenile transport results in higher rate of fallback and straying relative to in-river migrants and, therefore, longer adult migration time. Transported sockeye are 2.9 times more likely to fall back (Crozier et al., 2015). Use COMPASS for proportion transported (steelhead as surrogate for this metric)?	Percent of juvenile sockeye transported, use SARs from Chinook as a surrogate measure for relative differences in Alternatives Use sockeye data to test surrogate use. Conduct PTAGIS Search	Under the NAA ~ 39% of all Snake River sockeye will continue to be transported. These fish would be ~ 2.9 times more likely to fall back and experience delay. (Crozier et al., 2015)	No change ~ 39% Note: no confidence intervals calculated for juvenile chinook destined for transport. No Difference from NAA	Increase. (47%) Note: no confidence intervals calculated for juvenile chinook destined for transport. Expect increase in fallback when compared to the NAA	No Transport Expect reductions in fallback under MO3	Decrease. (7%) Note: no confidence intervals calculated for juvenile chinook destined for transport. Assume fallback, and lower migration delays.	Get data from NOAA, need to align with NAA spill. Straying, not shown a correlation with transport, but assume more fallback is correlated to more straying. Get baseline % from FPC/NOAA. 10-year average is 65,000 juveniles, need to convert to %: LWG is about 15%. Temperature and flow confound fallback - higher temperatures and higher flows lead to higher fallback (Crozier et al. 2018).
Higher water temperatures correspond to lower adult survival (less than 50% when water temperature is greater than 18°C ~ specific to BON). Use temperature for overriding predictor.	Temp - % days temps exceed 18°C at IHR Crozier used temp at Ice Harbor on the day of passage. Jun 21 thru July 31 to bracket 95% of the run. Used 80 year data set: % of all days Jun 21 - Jul 31 over 18°C	Percent of Days over 18°C Jun 21-July 31 at IHR: 78.7% Temperatures would exceed 18°C at Ice Harbor ~ 78% of all days during sockeye migration. Some years, temperature would continue to have negative impacts to the species. Extremely hot and dry years (e.g., 2015) would continue to result in losses to the sockeye run. Climate change could increase summer temperatures, but otherwise no change expected. Temperatures will continue to be above 18° C for periods of the year.	Percent of Days over 18C Jun 21-July 31 at IHR: 77.5% No change from NAA	Percent of Days over 18°C Jun 21-July 31 at IHR: 78.8% No change from NAA	Percent of Days over 18°C Jun 21-July 31 at IHR: 87.3% ~ three additional days over 18°C Under MO3 Sockeye would have greater thermal stress than under the NAA. However, removal of dams may reduce delays and decrease the time fish are exposed to these thermal stressor. Also would not have transportation effects that increase fallback.	Percent of Days over 18°C Jun 21 - Jul 31 at IHR: 78.7% No change from NAA	18°C is inflection point for survival/temp relationship at BON. Water quality standards vary; include narrative water quality standards. Cumulative temperature is critical at higher temperatures. Climate change impacts may be important for these fish. Compare water years at each alternative. Mitigation: additional cooling measures at LWG and other dams.

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Affected Environment Important Relationships/Criteria	Affected Environment Metric	Environmental Consequences NAA	Environmental Consequences MO1	Environmental Consequences MO2	Environmental Consequences MO3	Environmental Consequences MO4	Notes
Hydrosystem delays (operations and natural) result in migration period in later, hotter period). Transported fish are more likely to stray and spend additional time in hot water. Crozier may have relationship that the team can model.	Arrival timing at LGR correlated with temps at BON, MCN, LGR (from previous relationship).	In some years, sockeye would continue to be lost due to arrival timing coinciding with years where mainstem water temperatures become too high before the fish move through this corridor.	–	–	–	–	Later portion of the run gets too warm to survive. How would the team evaluate this? How do you predict arrival time? Do operations in system dictate or impact the arrival timing. Temperature already covers much of the delay. Covered in temperature metric above - delete.
Temps – delay in upstream adult migration more susceptible to harvest (in harvest area more time), and increase harvest in the thermal refugia areas. See temperature delays above.	Temps at MCN, BON, during upstream migration period Look at hottest years for differences in alternatives. Is this covered in Temperature metric above?	Influences of migration delays and warm temperatures would continue current levels influence on harvest exploitation rates.	–	–	–	–	Transported fish may also move back and forth through the harvest fishery area more. If temps increase, it would result in potentially more exploitation. However, does not affect total allowable harvest. Sockeye harvest is targeted to Mid-C stocks. If SR stock is delayed they get into the harvest. Metric did not detect differences in any alternative. Delete.
Flows affect adult migration – sockeye migrate faster at higher flows, but are likely confounded by temperature. Is this covered in the temperature metric above?	Flows and temp links. Mean flow at IHR Jun 21 – Jul 31	55,005 cfs Under the NAA SR Sockeye will continue to migrate upstream June through August.	56,675 cfs No change from NAA	52,082 cfs Under MO2 there will be a slight reduction in flows during SR Sockeye migration period. This reduction is ~ 5% of the normal flow under NAA. Negligible change in migration rate compared to the NAA.	54,975 cfs No difference from the NAA Need to discuss upstream migration in free flowing river vs reservoir environment in the EIS. Citations and write up - PTAGIS.	55,027 cfs No change from NAA	Migrate on descending end of the hydrograph. Correlate peak flows with temperatures. Sockeye show migration rates of between 17-30 miles per day. Flows can either induce migration or slow it. Follow up with Lisa Crozier. Team - need help on how to measure this relationship. Discuss at MO1 meeting. Suggest deleting.
Longer adult travel times correspond to lower adult survival. Conduct PTAGIS search for river travel times versus reservoir travel times.	Upstream Travel Time (Relationship with Flow?)	Adult fish will be delayed and survive at similar rates under the NAA.	–	–	–	–	Team – discuss how to predict increases or decreases in adult travel times. Travel time is tied to temperature and flow. Both already explored. Transportation effects on travel time also covers this. Was not the best predictor in Crozier et al. (2018).
Fallback – ladder temperatures can increase fallback if too warm. Currently, pumps cool the water; in NAA). Check Crozier et al. (2018) = Ladder temperature differential at Lower Granite was a significant predictor of fallback at Lower Granite.	Qualitatively describe if measures to improve ladder temps are in alternative.	–	–	–	–	–	Highest fallback rates, LGR, BON; This metric is tied to transport and temperature. Temperature differentials were not a good indicator of fallback in this analysis and transport analysis are done above. Differentials at LWG are already mitigated by pump. Delete.

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Adult ladder differentials of $\geq 2^{\circ}\text{C}$ can delay adult migration.	Frequency of adult ladder temp differentials of $\geq 2^{\circ}\text{C}$ (% days differential $> 2^{\circ}\text{C}$ at LMO Jun 20 thru Jul 31 ~ 95% of the migration). Difference between modeled surface and TW.	50.1% of all days with greater than 2°C differential. Under the NAA there is a risk of ladder delays on ~ 50% of all days during the migration.	65.5% of all days with $> 2^{\circ}\text{C}$ differential. There will be more risk of delay at Ladders under MO1. Installation of Pumps may reduce number of days with differentials	53.2% of all days with $> 2^{\circ}\text{C}$ differential. One day difference from NAA. No difference from NAA.	No Dams = No differentials. Any delays would not be the result of ladder temperature differentials.	58.9% of all days in Aug and Sep with $> 2^{\circ}\text{C}$ differential. Potential for more delay under MO4 Installation of Pumps May reduce number of days with differentials	Highest fallback rates, LGR, BON; This metric is tied to transport and temperature. Temperature differentials were not a good indicator of fallback in this analysis and transport analysis are done above. Make sure qualitative discussion covers the measures with pump installation. LMO had highest ladder differentials (Crozier et al. 2018).
TDG and Adults: What are the impacts to adults – research implications? Document TDG during time of migration – not total spill.	TDG: number of days over 120%, 125% at BON, MCN, LGR	BON: 120 = 10.8; 125 = 3.2 MCN: 120 = 6.8; 125 = 2.1 LGR: 120 = 2.7; 125 = 1.3 Under the NAA there would be minor impacts to Sockeye from TDG. GBD Impacts from elevated gas generally increase at 120%.	BON: 120 = 10.6; 125 = 2.9 MCN: 120 = 6.8; 125 = 1.8 LGR: 120 = 3.0; 125 = 1.5 No change from NAA	BON: 120 = 8.9%; 125 = 2.4% MCN: 120 = 4.4%; 125 = 1.2% LGR: 120 = 2.1%; 125 = 0.9% Under MO2, there would be fewer days over 120 and 125% TDG at all projects. Reduced negative impacts compared to NAA.	BON: 120 = 10.7%; 125 = 2.8% MCN: 120 = 9.4%; 125 = 1.4% LGR: 120 = 0.0%; 125 = 0.0% For BON and MCN, no difference from NAA. The lower Snake River projects would be removed and TDG would be greatly reduced. Reduced negative impacts to Sockeye.	BON: 120 = 25.8%; 125 = 3.7% MCN: 120 = 13.3%; 125 = 3.0% LGR: 120 = 22.6%; 125 = 12.9% More days over 120 and 125% would have greater negative impacts to Sockeye	Data collected during high flow conditions. Will begin to operate for high TDG under all flows. Talk to hatchery and adult trap personnel about effects to sockeye adults. TDG will be dropping as Sockeye adults pass dams. Look at TDG modeling for migration peak. Crozier et al. (2015 or 2018) discusses Gas metric. Shows negative relationship with survival and positive relationship with fallback. Spill driven?
TDG and Juveniles: Document TDG for outmigrating sockeye, not total spill.	TDG: number of days over 120%, 125% at BON, MCN, LGR	BON: 120 = 10.8; 125 = 3.2 MCN: 120 = 6.8; 125 = 2.1 LGR: 120 = 2.7; 125 = 1.3 Under the NAA there would be minor impacts to Sockeye from TDG. GBD Impacts from elevated gas generally increase at 120%.	BON: 120 = 10.6; 125 = 2.9 MCN: 120 = 6.8; 125 = 1.8 LGR: 120 = 3.0; 125 = 1.5 No change from NAA	BON: 120 = 8.9%; 125 = 2.4% MCN: 120 = 4.4%; 125 = 1.2% LGR: 120 = 2.1%; 125 = 0.9% Under MO2 there would be fewer days over 120 and 125% TDG at all projects. Reduced negative impacts compared to NAA.	BON: 120 = 10.7%; 125 = 2.8% MCN: 120 = 9.4%; 125 = 1.4% LGR: 120 = 0.0%; 125 = 0.0% For BON and MCN no difference from NAA. The lower Snake River projects would be removed and TDG would be greatly reduced. Reduced negative impacts to sockeye.	BON: 120 = 25.8%; 125 = 3.7% MCN: 120 = 13.3%; 125 = 3.0% LGR: 120 = 22.6%; 125 = 12.9% More days over 120 and 125% would have greater negative impacts to Sockeye	Data collected during high flow conditions. Will begin to operate for high TDG under all flows. Benefits can outweigh TDG negative effects.

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Tolerance to Sediment	Sediment levels in mg/l	Average concentration under current conditions ~ 2 mg/l Under the NAA no negative impacts are expected from sediment levels.	No change from NAA	No change from NAA	Estimates of nearly 25,000 mg/l during breach and 30 mg/l after breach. 27 days over 5,000 mg/l. Timing of breach currently occurs at the tail end of the sockeye migration. Severity index (Newcombe et al., 1996) of 11 indicates mortality between 20% and 40% of fish downstream of these dams. However, most of the Sockeye run will have passed the dams by the time these levels are reached. No change from NAA. May be long term impacts from spring freshets the following years.	–	–
Tolerance to DO levels	DO concentrations	Under the NAA, Most stations on the Snake River are between 9.5 and 11 mg/l. Under the NAA, no negative impacts are expected from reduced Oxygen concentrations.	No change from NAA	No change from NAA	Estimate of dissolved oxygen levels dropping to ~ 2 mg/l throughout the LGS and LMO pool in year one. May be some loss of late migrating sockeye in these two pools during the peak of sediment release, but most of them will have already passed.	–	–

Note: + Reference to surrogate

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Erhardt, John M., Kenneth F. Tiffan, Rulon J. Hemingway, Brad K. Bickford, and Toby N. Rhodes. 2018. Smallmouth bass predation on subyearling fall Chinook salmon in Lower Granite Reservoir, 2016–2017. USGS.

Faulkner,

Newcombe, C.P. and J.O.T. Jensen. 1996. Channel Suspended Sediment and Fisheries: A Synthesis for Quantitative Assessment of Risk and Impact. North American Journal of Fisheries Management 16:693-727.

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3.6.9 Snake River Fall-Run Chinook Salmon

Table 3-61. Snake River Fall Chinook Salmon Qualitative Effects Analysis Matrix

Affected Environment Important Relationships/Criteria	Affected Environment Metric	Environmental Consequences NAA	Environmental Consequences MO1	Environmental Consequences MO2	Environmental Consequences MO3	Environmental Consequences MO4	Notes
Spawning, Incubation, and Egress							
Access to acceptable size spawning gravel affects spawning success.	Availability of substrate with sediment size from 1-12 inches - (spring/summer Chinook can use gravel down to pea size, would assume fall Chinook would as well if that was only available. 12" seems too large for the size of most SR fall Chinook to move).	Suitable substrates occur mainly in tailraces below project dams. Mainstem spawning is limited in the CRSO project area, primarily in lower Snake dam tailraces. Additional spawning upstream of CRSO project area between Hells Canyon Complex and upstream of Lower Granite reservoir, including the Clearwater River. Construction of the Lower Snake projects inundated fall Chinook spawning habitat. (Corps, 2002).	Sediment distribution assumed similar to NAA.	Sediment distribution assumed similar to NAA.	2002 LSR Feasibility Report estimates and increase from 226 to 3,521 acres of spawning habitat for fall chinook in the lower Snake River (15-fold increase) under a breach scenario.	Sediment distribution assumed similar to NAA.	Some indication of flattening in S/R relationship which may indicate spawning/rearing habitat limitation at some streams.
Acceptable water depth is necessary for successful spawning.	Availability of water depth from 4-8.1 meters. Use the values below for MO3 and other river reaches. However, same study showed that fall chinook used different depths in river reaches (i.e., <1-4 meters in Hells Canyon Reach). Combine metric - depths 1 to 8 meters in depth.	Depth is not a limiting factor for Fall Chinook spawning. Mainstem spawning is limited in the CRSO project area, primarily in lower Snake dam tailraces. Additional spawning upstream of CRSO project area between Hells Canyon Complex and upstream of Lower Granite reservoir, including the Clearwater River. Construction of the Lower Snake projects inundated fall Chinook spawning habitat. (Corps, 2002).	Depth availability assumed similar to current conditions. No Effect	Depth availability assumed similar to current conditions. No Effect	Mean depths will be dramatically reduced. However, studies showed that fall chinook used different depths in river reaches (i.e. 1-4 meters in Hells Canyon Reach). 2002 LSR Feasibility Report estimates and increase from 226 to 3,521 acres of spawning habitat for fall chinook. MO3 would lead to increases in spawning habitat and Improved conditions for spawning	Depth will be 0.75 feet greater for ~60% of years. No Effect	Dauble et al. (1998) from survey data 1993-1997: "Redds were in water from 4.0 to 8.1 m deep and on cobble substrate. All redds were adjacent to the outfall flow from juvenile fish bypass systems and on the powerhouse side of the river." In the Upper and Lower Hells Canyon reach, spawning in 1993-1995 redds were primarily at 1-4.5m depths (Connor et al 2018, data reproduced from Groves and Chandler 1999). Note: current operations (flows) at DWA do not adversely affect current available spawning habitat. However, the presence of Dworshak Dam precludes access to historical spawning and rearing habitat. No underwater spawning surveys were conducted below any of the four lower Snake River dams during 2018. Surveys have shown that Snake River Fall Chinook spawn in some areas in the tailraces of the projects.

Affected Environment Important Relationships/Criteria	Affected Environment Metric	Environmental Consequences NAA	Environmental Consequences MO1	Environmental Consequences MO2	Environmental Consequences MO3	Environmental Consequences MO4	Notes
Juvenile transportation affects adult returns and adult stray rates (relative to juvenile in-river migration).	Proportion and timing of juveniles transported downstream from collector projects.	NAA fall chinook transportation rate = 39% transported under NAA Transport effects on Snake River fall Chinook juveniles: - Mixed/uncertain from mid-May to mid-June - Improves adult returns from mid-June to end of November	38% transported under MO1 No difference in returns or stray rates when compared to the NAA	Maximum transport under MO2 - 47% transported under MO2. NOAA modeling for spring/summer Chinook shows increases in adult returns, while CSS modeling shows a decrease in adult returns under MO2. Stray rates would likely increase relative to the NAA.	No transport under MO3 Reduced stray rates relative to the NAA Increased returns relative to the NAA.	7% transported under MO4 Spill will reduce transport of Fall Chinook under MO4 Arrival timing will be later Reduced strays relative to NAA NOAA modeling for spring/summer Chinook show decreases in adult returns, while CSS modeling shows an increase in adult returns under MO4. Likely reduced survival of juvenile population.	CSS SAR: LGR to LGR ratios (TIR) from 2006-2015, 52 cohorts: 31 cohorts higher LWG-LWG for juveniles migrating in-river, 19 cohorts lower LWG-LWG for juveniles migrating in-river (transport benefit). Significant difference from 0 reduces these differences. With current spill program we generally collect and transport more juveniles in higher water years (higher proportion spill in low water year and same proportion spill more effective in a low water year. Need qualitative discussion of water year differences. Low water years generally have higher transportation. Based on Smith et al 2018 transportation does not provide a consistent survival advantage early in the season. However, beginning in July there is a transport advantage later in the season.
Juvenile Mainstem Rearing and Passage							
Warmer water temperatures and concentrations of juveniles/predators at dam structures make juvenile salmonids more susceptible to piscine predators (channel catfish, walleye, pikeminnow, smallmouth bass; Northern Pike are coming).	Increase or decrease in mainstem temperatures during migration as a surrogate for predation risk. May - July average temperature at IHR and Percent of days over 20°C	Mean Temp NAA 16.5. 26.6% of days over 20°C. Currently exceeding 20°C in nearly every year. Current water temperatures would have minor impacts to juvenile chinook. An unknown number of these fish would be lost to predation.	Mean temp 16.4 25.2% of days over 20°C Slightly lower temperatures and fewer days over 20°C when compared to the NAA. Under MO1 there would be a negligible reduction in predation risk May through July.	Mean water temperature for May through July = 16.7C. 27.0% of days over 20°C No difference from NAA	Mean Water temperature for May through July = 16.7C. 35.6% of days over 20°C Slight increase in temperatures and days over 20C compared with the NAA. The cold water flow augmentation from DWR should be more effective with smaller cross sectional area to cool down in July and August Assumed that current holdovers will move from the Snake River - MCN pool or downstream and assume that proportion of holdovers will be reduced. Significantly Faster travel times would reduce predation risk substantially.	Mean temp 16.5. 26.4% of days over 20°C No Difference from NAA	Piscine predators include Smallmouth, northern pikeminnow, Walleye, and catfish. Walleye are increasing in abundance. Compensatory mortality (swamping predators) - easier to account for spring migrants than fall chinook; not a metric per se but account for this in predation effects analysis/estimates Could use survival of fish from upriver traps to LGR as a surrogate for lower Snake River survival in predation. 20°C may capture the relative change, but these piscine predators become very active at even cooler temperatures Temperatures affect survival via predation and increased energetic requirements; disease (columnaris).

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Avian predation – avian nesting habitat increases or decreases.	Increase or decrease in avian nesting habitat.	No change in avian nesting is expected. Predation would not change under the NAA.	Reduced nesting habitat via Blalock island inundation and additional hazing. Predation Risk may decrease as a result of JDA pool operations – dissuade nesting at Blalock – limited in fall chinook. Earlier migrants (steelhead and Sockeye) are more impacted.	No change from NAA	Increase in nesting habitat expected in lower Ice Harbor pool. Only those islands that would not be inundated in spring flows and are suitable habitat. Risk of avian predation will likely decrease as travel times decrease and turbidity increases under MO3 and reduce exposure to avian predators. (see travel times under MO3)	No change from NAA	Islands in free flowing Snake River do not have avian colonies. Would they use the lower Snake? Predation rate trend (or abundance if predation rate unknown). Estimate of 11.6% predation on Chinook by avian predators in 2014. Compensatory mortality (swamping predators) - easier to account for spring migrants than fall chinook; not a metric per se but account for this in predation effects analysis/estimates
Rearing habitat in reservoirs supports overwintering fall Chinook life history.	Presence absence of reservoirs	Reservoirs Present. Reservoirs provide rearing habitat for one of the fall chinook life histories that overwinters in reservoirs.	No change from NAA Some holdover may be due to cool water refugia in reservoirs. Reduced summer cooling water in MO1 may reduce quality of rearing habitat to Holdover fish.	No change from NAA	Reservoirs not present - Holdover fish would likely move to MCN and JDA to overwinter or outmigrate to the ocean. We expect fewer holdovers under MO3.	No Change from NAA	Presence absence of reservoirs
TDG downstream of DWA.	Elevated TDG (specific criteria?) degrades juvenile rearing habitat and may negatively affect downstream hatcheries. Mean, Maximum and % days over 110%.	TDG below DWA: Mean = 101.5; Max = 130.9; % over 110 = 2.8% TDG in the Clearwater downstream from DWA would have negligible impact to fish populations.	Mean = 101.7; Max ~ 130.2; % over 110 = 3.0% No difference from NAA	Mean = 101.5; Max = 131.6; % over 110 = 2.5% No difference from NAA	Mean = 101.3; Max = 130.9; % over 110 = 2.9% No difference from NAA	Mean = 101.2; Max = 130.9; % over 110 = 2.9% No difference from NAA	Restricting upper part of shallow water Hatchery risks to TDG – Call to get value of concern > 105% TDG Recommend deleting this variable as it does not help in decision making
Higher turbidity decreases predation rates. Higher turbidity within a range hides juveniles so predation rates would decrease.	Expected increase or decrease in water turbidity, especially near dam structures. Are there specific criteria? Turbidity during outmigration May-July - use sediment data as surrogate ~	2 mg/l on average year (not spring freshet). Current River mechanics data. Current	No Expected Change relative to NAA	No Expected Change relative to NAA	Expect higher sediment under MO3 ~ 30 mg/l on average. Outmigrating fall chinook would experience a decrease in predation risk under MO3. Current River mechanics data.	No expected change relative to NAA until McNary tailrace. Forebay elevation manipulations at JDA to disrupt bass/walleye spawning and drawdown to MOP measures may have minor TSS/turbidity impacts, but impacts not expected to be great in large reservoirs.	–

Affected Environment Important Relationships/Criteria	Affected Environment Metric	Environmental Consequences NAA	Environmental Consequences MO1	Environmental Consequences MO2	Environmental Consequences MO3	Environmental Consequences MO4	Notes
BON – BON (Estuary, Plume, Ocean)							
Predation by non-SRKW marine mammals (sea lions, seals, otters) will continue and may increase.	CRSO Wildlife Team - pinniped abundance trends by location (Astoria, BON).	Pinnipeds growing in numbers - expect	No change from NAA Check with Bjorn on Spill sea lion relationship.	No change from NAA	No change from NAA	No Change from NAA	Compensatory mortality (swamping predators) - easier to account for spring migrants than fall chinook; not a metric per se but account for this in predation effects analysis/estimates Emerging stellar sea lion numbers eating adult fall chinook (and others); some prey switching suspected from w. sturgeon to salmonids.
Predation by SRKWs will continue and may decrease.	Predation rate trend (or abundance if predation rate unknown)	No Measure changes risk to predation from Orcas.	No change from NAA	No change from NAA	No change from NAA	No Change from NAA	SRKWs are feeding on adult fall Chinook during XX months. Unclear if diet analysis for SRKW; spatial seasonality. Orca task force, ranking salmonids in terms of diet importance. No known measures that puts Chinook at greater risk to predation from SRKW - Remove.
Adult Mainstem Passage							
High water temperatures can cause migrating adult salmon to stop or delay their migration or can increase fallback at a dam. Water temperatures delay adult migration during summer/fall when they exceed 20°C (68°F).	Frequency of water temperatures from Lower Granite to Bonneville that exceed 20 °C (68 °F) August through September at MCN and IHR and BON	Percent of days over 20°C: MCN 58.3% of all days over 20°C; Mean temp = 20.3°C IHR 54.3% BON 46.8% During August and September under the NAA nearly 60 percent of all days at MCN dam are over 20°C. Would expect potential delays in adult migration as a result of elevated temperatures during August. Effect generally Reduced as you move downriver.	MCN 59.3% of all days over 20°C; Mean temp = 20.4°C IHR 62.7% BON 45.2% Minor increase in risk of delay and fallback under MO1 because of changes to cooling water augmentation from DWA.	MCN 57.6% of all days over 20°C; Mean temp = 20.3°C IHR 54.4% BON 45.2% No change from NAA.	MCN 52.4% of all days over 20°C; Mean temp = 20.1°C IHR 29.2% BON 45.2% Minor decrease in risk of delay as Cooler late summer and fall waters would reduce delays in August under MO3.	MCN 58.9% of all days over 20°C; Mean temp = 20.4°C IHR 54.3% BON 45.7% No change from NAA.	Warm water temperatures can also increase the fishes’ susceptibility to disease. All reduce survival and spawning success (gamete viability included). Increased adult straying with elevated temps (e.g., Deschutes/thermal refuges). Mean water temperature is not an effective measure in this metric. Need to look at annual variation. Egg viability would decrease and pre-spawn mortality would increase as temperatures increase. - Check literature for metric. Cumulative thermal stress on migrating adults - Transported adults vs in river migrants on warm water years. Note: no standard deviation available to estimate statistical significance.
Adult ladder differentials of ≥2°C can delay adult migration.	Frequency of adult ladder temp differentials of >2°C (% days differential > 2°C at LMN August through September).	50.1% of all days with greater than 2°C differential. Potential for delay under NAA is about 50%.	65.5% of all days in Aug and Sep with > 2°C differential. Increase risk of delay under MO1 ~ 9 more days with > 2°C differentials than the NAA. Installation of pumps may reduce number of days with differentials.	53.2% of all days in Aug and Sep with > 2°C differential. No difference from NAA.	No Dams = No differentials.	58.6% of all days in Aug and Sep with > 2°C differential. Slight increase in risk of delay under MO4 ~ 5 more days with > 2°C differentials than the NAA. Installation of Pumps may reduce number of days with differentials.	Can use relationship between surface and deep water to modify current water quality output at dams with pumps installed. Assume low water years with higher temperatures would have much greater differential delays.

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Dworshak cooler temperature releases during summer affect the proportion of juveniles with reservoir rearing life history.	Continuation of Dworshak cool water releases in July-August Temperature at DWA tailwater July-August Relative increase or decrease in the reservoir rearing juvenile life history?	North Fork Clearwater mean temperature for July and August = 6.88 Under NAA cold water releases from DWA will continue to suppress juvenile growth and induce holdover fish.	North Fork Clearwater mean temperature for July and August = 7.23 Warmer water in August may increase juvenile growth rates slightly (not statistically significant SD = 1.01)	North Fork Clearwater mean temperature for July and August = 6.89 No change from NAA	North Fork Clearwater mean temperature for July and August = 6.84 No change from NAA	North Fork Clearwater mean temperature for July and August = 7.01 Warmer water in August may increase juvenile growth rates slightly (not statistically significant SD = 1.01)	The spawn timing also starts earlier in the Clearwater. Surrogate: use gauge above the north fork confluence for water temperatures. Is this a good metric for separating alternatives? Operations are not changing that much at DWA. Not used. Look at August and July separately to see differences. Sudden increases in august temperatures will be detrimental for smolts The temperature releases affect juvenile growth in the Clearwater and yearling/subyearling proportions (life history proportion for Clearwater). Cooler water reduces growth rates and induces holdover of fall chinook.
Dworshak temperature releases related to refugia for adult fish.	Continuation of Dworshak cool water releases in July-August	Current conditions provide refuge for Steelhead	Reduction in cold water for August would increase temperature stress of adult steelhead and chinook.	No change from NAA	No change from NAA	Reduction in cold water for August would increase temperature stress of adult steelhead and chinook.	Coldwater in the Clearwater River creates a refuge from hot water in the snake river for adult fall Chinook and steelhead. However, this metric is only changed in MO1 and is not otherwise useful for identifying an alternative.
Tolerance to sediment.	Sediment concentrations measured in mg/l	Average concentration under current conditions ~ 2 mg/l Under the NAA no negative impacts are expected from sediment levels.	No change from NAA	No change from NAA	Estimates of nearly 25,000 mg/l during breach and 30 mg/l after breach. 27 days over 5,000 mg/l. Timing of breach currently occurs in the fall chinook, steelhead, and coho migrations. Severity index of 11 indicates mortality between 20 and 40 percent.	No change from NAA	See Newcombe et al. (1996) for severity index from sediment loads.
Tolerance to DO levels.	Temperature at DWA tailwater July-August	Saturations. Most stations on the Snake River are between 9.5 and 11 mg/l. Under the NAA no negative impacts are expected from reduced Oxygen concentrations.	No change from NAA	No change from NAA	Estimate of dissolved oxygen levels dropping to ~ 2.5 mg/l throughout the LGS and LMO pool in year one. Expect loss of fall chinook, coho, and steelhead in these two pools during the peak of sediment release.	No change from NAA	–

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3.6.10 Lower Columbia River Coho Salmon

Table 3-62. Lower Columbia River Coho Salmon Qualitative Effects Analysis Matrix

Affected Environment Important Relationships/Criteria	Affected Environment Metric	Environmental Consequences NAA	Environmental Consequences MO1	Environmental Consequences MO2	Environmental Consequences MO3	Environmental Consequences MO4	Notes
Project survival through BON reservoir and dam affects the juvenile lower Columbia Gorge coho salmon from BON pool tributaries.	There is no direct estimate of BON project survival (dam and reservoir) specific to coho, so juvenile Snake River spring Chinook BON project survival as a surrogate estimate. ¹ Estimate change in BOLN survival (e.g., MO1-NAA)/NAA), for juvenile Snake River spring Chinook using COMPASS survival estimates as surrogate for lower Columbia River coho.	Estimated BON project survival (95% lower and upper confidence intervals) from 2019 CRS BiOp, page 861: 95.5% (94.6% to 96.2%)	0.2% survival decrease relative to NAA (COMPASS). No dam-specific survival estimate available from CSS.	0.6% survival increase relative to NAA (COMPASS). No dam-specific survival estimate available from CSS.	0.5% to 0.8% survival increase relative to NAA (COMPASS). No dam-specific survival estimate available from CSS.	0.9% survival decrease relative to NAA (COMPASS). No dam-specific survival estimate available from CSS. NOTE: This alternative does not contain BON 150 kcfs voluntary spill constraint associated with stilling basin integrity. Adding the constraint would reduce SPE.	Apply change in survival for spring Chinook salmon as qualitative surrogate for LCR coho. Surrogate for lower Columbia River coho was Snake River spring Chinook in 2008 BiOp, 2013 Recovery Plan, 2019 BiOp, due to lack of dam passage survival estimate specific to lower Columbia River coho salmon. Same estimated response as lower Columbia River Chinook and Columbia River chum – 2013 Recover Plan, Table 4-4 (citing NMFS 2008a; 201a), Appendix E, Table 3 (page 32).
Adult upstream passage at BON and reservoir affects survival rate for the coho populations that migrate to natal streams within BON pool.	Adult Snake River fall Chinook salmon passage analysis at BON as surrogate for adult coho passage considerations. ²	BON dam and pool survival 97.6 (94.5 to 100), estimate from 2019 CRS BiOp, page 854.	See change in fall Chinook salmon upstream passage for MO1.	See change in fall Chinook salmon upstream passage for MO1.	See change in fall Chinook salmon upstream passage for MO1.	See change in fall Chinook salmon upstream passage for MO1.	Same estimated response as lower Columbia River Chinook adults (fall run) and Columbia River chum – 2013 Recovery Plan, Table 4-4 (citing NMFS 2008a, 2010a), Appendix E, Table 1, page. 26). Use DART for adult coho return timing (http://www.cbr.washington.edu/dart/quick_look/adult).

¹Coho-specific dam survival measurements are not available, but coho-specific in-river survival estimates are available for current system conditions. There are no coho-specific models available to predict changes in these metrics from CRS alternatives. However, survival models that project changes in these metrics based on changes in hydrosystem operation and configurations are available for spring Chinook salmon and steelhead (COMPASS, CSS). Coho salmon outmigration timing generally overlaps with both spring Chinook salmon and steelhead, and all three species have dominant stream-type life histories. However, the size of juvenile coho and juvenile spring Chinook salmon tend to be more closely aligned than juvenile steelhead. Therefore, juvenile spring Chinook salmon will be considered the appropriate surrogate for juvenile coho salmon for purposes of qualitative effects analysis of changes in passage. This use of juvenile Snake River spring Chinook salmon as a surrogate for juvenile lower Columbia River coho salmon is consistent with the 2008 FCRSP BiOp, 2013 Recovery Plan, and 2019 CRS BiOp.

²Dam survival and reach survival measurements specific to adult coho are not available for the previous 10-year period. Adult Coho salmon upstream migration timing general overlaps with fall Chinook salmon, through fall Chinook salmon migration timing tends to start earlier in some years (DART). Far more adult fall Chinook salmon enter the CRS system than Coho salmon adults, so survival estimates generally have higher certainty for the former than the latter. Adult fall Chinook salmon will be considered the appropriate surrogate for adult coho salmon for purpose of qualitative effects analysis of changes in passage. This use of adult Snake River fall Chinook salmon as a surrogate for adult lower Columbia River coho salmon is consistent with the 2008 FCRPS BiOp, 2013 Recovery Plan, and 2019 CRS BiOp.

NOTE ABOUT OCEAN SURVIVAL: The CSS (2017) makes no prediction in terms of survival benefits for lower Columbia River, upper Columbia River, or lower Snake River coho salmon. The CSS predicts that increased spill could substantially reduce latent mortality of juvenile yearling Chinook salmon and steelhead moving downstream through the mainstem dams. If this were to occur for coho salmon, SARs would also be improved for the XX populations that pass above XX dams and migrate during the spring, and the potential benefit would generally be less than what may occur for species that experience passage through a greater number of Columbia and Snake River mainstem dams (NMFS, 2019). The COM

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3.6.11 Lower Columbia River Chum Salmon

Table 3-63. Lower Columbia River Chum Salmon Qualitative Effects Analysis Matrix

Affected Environment Important Relationships/Criteria	Affected Environment Metric	Environmental Consequences NAA	Environmental Consequences MO1	Environmental Consequences MO2	Environmental Consequences MO3	Environmental Consequences MO4	Notes Spawning, Incubation, and Egress
Ability to meet the chum operation. BON tailwater elevation (measured at Tanner Creek gage) affects chum access to the Ives/Pierce Islands spawning area and local tributaries: BON tailwater elevation below 11.3 feet creates connectivity issues to spawning channels and poorer conditions in the lower spawning elevation habitat. Chum have access to spawning habitat when BON tailwater elevation ranges from 11.3 feet to 13.5 feet. When elevation exceeds 16.5 feet, chum are unable to hold in typical	(1a) Frequency (years) of meeting chum operation, without tradeoff between abandoning chum or lower April 10 elevation at GCL and (1b) (In those years when chum redds/fry would be abandoned without additional releases from upstream storage) The water volume that would need to be released from storage to meet the chum operation (lowest is best).	(1a) 92% of years (1b) 0.18 Maf	(1a) 90% of years (additional releases from upstream storage needed in more years, relative to NAA) (1b) 0.13 Maf (in years that upstream storage needed to meet chum operation, less water needed from upstream storage relative to NAA)	(1a) 89% of years (additional releases from upstream storage needed in more years, relative to NAA) (1b) 0.12 Maf (in years that upstream storage needed to meet chum operation, less water needed from upstream storage relative to NAA)	(1a) 93% of years (additional releases from upstream storage needed in fewer years, relative to NAA) (1b) 0.08 Maf (in years that upstream storage needed to meet chum operation, less water needed from upstream storage relative to NAA)	(1a) 80% of years (additional releases from upstream storage needed in more years, relative to NAA) (1b) 0.24 Maf (in years that upstream storage needed to meet chum operation, more water needed from upstream storage relative to NAA)	2008/2010/2014 NOAA Fisheries BiOp RPA 17 Chum Spawning Flows (page 19) 2019 BiOp (pages 267-668) 2018 Water Management Plan (pages 9, 34, 40-46) Tomaro et al 2007 PNNI - 20035 Grays/Chinook, Washougal, and lower Gorge populations together produce the majority of Columbia River chum salmon. Grand Coulee is operated to balance the needs of chum flows, Hanford reach ops, and spring flow augmentation from two months before the start of chum spawning in Nov through the end of chum emergence (approximately end of Apr) to maintain sufficient water depth to protect chum spawning and incubation habitat at the Ives Island complex below BON.

Affected Environment Important Relationships/Criteria	Affected Environment Metric	Environmental Consequences NAA	Environmental Consequences MO1	Environmental Consequences MO2	Environmental Consequences MO3	Environmental Consequences MO4	Notes Spawning, Incubation, and Egress
spawning areas due to water velocities. Protection level is set by spawning elevations identified by field verification in late December (may be 11.3 feet to 12.0 feet, depending on surveys) so the redds have sufficient water covering them to prevent desiccation post-spawning and this water level is maintained until Apr 9, though chum emergence typically ends by the end of Mar. Allowance for periods rewetting depending on water availability, in-season adaptive management by TMT.							
105% TDG appears to provide a sufficient level of protection to chum salmon sac fry incubating in the gravel downstream of BON in the Ives/Pierce Island Complex. TDG must remain at or below 105% after depth compensation of 3% per foot from Nov 1 to Apr 30.	Average number of years TDG exceeds 105% in chum spawning areas in the Ives/Pierce Island areas between Nov 1 and Apr 30. This will be measured consistent with TMT method for estimating Ives/Pierce TDG: Based on WRNO gage, calculating feet of depth compensation required to reach 105% TDG; Subtracting 11.3 feet from BON tailwater elevation (Tanner Creek gage) to determine feet of depth compensation; If the TDG estimate exceeds 105% at Ives/Pierce Island, then the assumption is that the chum redds were exposed to TDG in excess of 105%.	5 years out of 80; average exceedance 107% TDG	7 years out of 80; average exceedance 106% TDG (increase in frequency of exposing chum fry relative to NAA)	4 years out of 80; average exceedance 106% TDG (decrease in frequency of exposing chum fry relative to NAA)	7 years out of 80; average exceedance 106% TDG (increase in frequency of exposing chum fry relative to NAA)	30 years out of 80; average exceedance 107% TDG (increase in frequency of exposing chum fry relative to NAA)	Chum fry emerge in the Ives Island area until approximately the end of March (Hamilton & Hardy Creek, Hamilton Springs fry; Ives area fry emerge earlier due to warmer incubation temps). NAA spring spill for upstream salmon and steelhead starts April 10th. From PNNL-16200: Both the Ives and Multnomah Falls sites were influenced by groundwater. However, at Multnomah Falls, despite significant fluctuations in river concentrations of total dissolved gas, dissolved oxygen, and temperature, egg pocket concentrations remained stable, suggesting relatively constant groundwater discharge there. In contrast, egg pocket responses at the Ives Island site fluctuated widely in response to changes in river water quality, suggesting spawning gravels in the Ives area are in much closer contact with river water. From PNNL-18081: Surface water TDG was generally lower at Bonneville and Ives Island stations compared to that measured at Warrendale and Camas/Washougal. The TDG records from all of the sites were very highly correlated with one another (correlation coefficient of at least 0.84) except for Cascades Island, which had a correlation coefficient of between 0.60 and 0.69 when compared to the other locations. Excluding Cascades Island, all correlation coefficients from the 2007 monitoring season were above 0.91.

Affected Environment Important Relationships/Criteria	Affected Environment Metric	Environmental Consequences NAA	Environmental Consequences MO1	Environmental Consequences MO2	Environmental Consequences MO3	Environmental Consequences MO4	Notes Spawning, Incubation, and Egress
Juvenile Mainstem Passage							
BON dam passage route affects survival for juvenile upper Gorge chum that pass BON. Note: Few juvenile chum migrate through the BON pool and dam, most chum spawn downstream of BON.	There is no direct estimate of BON project survival (dam and reservoir) specific to juvenile chum, so juvenile Snake River spring Chinook BON project survival will be used as a surrogate estimate. ¹ Estimate change in BON survival, e.g. (MO1-NAA)/(NAA), for juvenile SR spring chinook using COMPASS survival estimates as surrogate for Columbia River chum response. WA comments that models using spring chinook smolts to identify increases or decreases in survival among different operational options for Bonneville Dam will not provide accurate information for chum fry (and age 0 spring Chinook fry) and is not supported by WDFW. WDFW is concerned that operating Bonneville's second powerhouse above the mid-point of the 1 % efficiency curve will result in higher levels of mortality, injury and descaling to juvenile chum salmon when they are present.	Estimated BON project survival (95% lower and upper confidence intervals) from 2019 CRS BiOp p. 861: 95.5% (94.6% – 96.2%)	0.2% survival decrease relative to NAA (COMPASS) No dam-specific survival estimate available from CSS. (no change relative to relative to NAA)	0.6% survival increase relative to NAA (COMPASS) No dam-specific survival estimate available from CSS. (about 1% increase in project survival relative to NAA)	0.5-0.8% survival increase relative to NAA (COMPASS) No dam-specific survival estimate available from CSS. (about 1% increase in project survival relative to NAA)	0.9% survival decrease relative to NAA (COMPASS) No dam-specific survival estimate available from CSS. (about 1% decrease in project survival relative to NAA)	Surrogate for juvenile Columbia River chum passing BON was SR spring Chinook in 2008 BiOp, 2013 Recovery Plan, 2019 BiOp due to lack of dam passage survival estimate specific to Columbia River chum. Same estimated response as lower Columbia River Chinook and coho salmon - 2013 Recovery Plan Table 4-4 (citing NMFS 2008a; 2010a), Appendix E Table 3 (p. 32).

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3.7 OTHER ANADROMOUS FISH

3.7.1 Pacific Eulachon

Table 3-64. Pacific Eulachon Qualitative Effects Analysis Matrix

Affected Environment Important Relationships/Criteria	Affected Environment Metric	Environmental Consequences NAA	Environmental Consequences MO1	Environmental Consequences MO2	Environmental Consequences MO3	Environmental Consequences MO4	References																																																																																																																																																
Criteria for eulachon: 7-day average of the daily maximum temperatures no exceed 12°C to 14°C prior to May 1, with no single daily maximum temperature greater than 16°C.	BON tailwater temperature: Dec 1 to May 1 (from extended year set 5 water year types).	H&H and WQ Outputs: 2011: All temps <9.0°C 2012: All temps <11.7°C 2013: All temps <11.4°C 2014: All temps <10.8°C 2015: All temps <12.2°C Effects to Resource NAA: All temperatures from Dec 1 to May 1 (modeled) well below the threshold of 12°C to 14°C. Temperatures would continue to be suitable for eulachon. Notes: Added from recovery plan.	Data Outputs: 2011: All temps <9.0°C 2012: All temps <11.6°C 2013: All temps <11.7°C 2014: All temps <11.0°C 2015: All temps <12.2°C Effects of MO1 compared to NAA: Same as NAA.	Data: Same as NAA. All temps within 0.6° of NAA. Effects: Same as NAA.	Data: 2011: All temps <9.3°C 2012: All temps <12.0°C 2013: All temps <11.5°C 2014: All temps <11.1°C 2015: All temps <12.3°C Note: Average monthly temps about 0.2°-0.3° cooler in winter months. Effects: Same as NAA.	Data Outputs: 2011: All temps <9.0°C 2012: All temps <11.6°C 2013: All temps <11.4°C 2014: All temps <11.1°C 2015: All temps <12.1°C Effects of MO4 compared to NAA: Same as NAA.	NMFS 2017																																																																																																																																																
Predation: Avian predation risk can be influenced by flow – higher flows are linked to more eulachon and salmon predation, with lower flows, the birds tend to switch to marine prey.	Qualitative change in avian predation risk, based on change in flows. Mean monthly flows; Columbia and Willamette, Nov to Jun.	H&H and WQ Outputs: <table><tr><th>Month</th><th>25%</th><th>Med</th><th>75%</th></tr><tr><td>Nov</td><td>218919</td><td>177945</td><td>155471</td></tr><tr><td>Dec</td><td>275908</td><td>225221</td><td>185592</td></tr><tr><td>Jan</td><td>308713</td><td>251732</td><td>195846</td></tr><tr><td>Feb</td><td>318765</td><td>266760</td><td>216851</td></tr><tr><td>Mar</td><td>282091</td><td>232780</td><td>195023</td></tr><tr><td>Apr</td><td>307054</td><td>260370</td><td>210833</td></tr><tr><td>May</td><td>366718</td><td>314137</td><td>274443</td></tr><tr><td>Jun</td><td>390625</td><td>319041</td><td>256963</td></tr></table> Effects to Resource NAA: Eulachon would continue to be affected by predation, dependent upon a number of factors that affect predation risk.	Month	25%	Med	75%	Nov	218919	177945	155471	Dec	275908	225221	185592	Jan	308713	251732	195846	Feb	318765	266760	216851	Mar	282091	232780	195023	Apr	307054	260370	210833	May	366718	314137	274443	Jun	390625	319041	256963	Data Outputs: Percent Change by Month <table><tr><th>Month</th><th>25%</th><th>Med</th><th>75%</th></tr><tr><td>Nov</td><td>0%</td><td>0%</td><td>0%</td></tr><tr><td>Dec</td><td>1%</td><td>2%</td><td>3%</td></tr><tr><td>Jan</td><td>0%</td><td>0%</td><td>1%</td></tr><tr><td>Feb</td><td>-1%</td><td>-1%</td><td>-1%</td></tr><tr><td>Mar</td><td>-1%</td><td>-1%</td><td>-2%</td></tr><tr><td>Apr</td><td>-2%</td><td>-2%</td><td>-2%</td></tr><tr><td>May</td><td>-2%</td><td>-2%</td><td>-2%</td></tr><tr><td>Jun</td><td>-1%</td><td>-1%</td><td>-1%</td></tr></table> Effects of MO1 compared to NAA: Relatively little change (0% to 3%) in all months and water year types. Slightly higher flows in December could increase predation risk, slightly lower in Feb to June could result in slightly less predation risk if the birds switch to more readily available marine prey. Early portion of run comes in about Nov to Dec timeframe may be more subject to predation. Note the change is likely immeasurable. Such a slight change in flow likely not cause an effect on the biological scale. Notes: No present in July to Oct.	Month	25%	Med	75%	Nov	0%	0%	0%	Dec	1%	2%	3%	Jan	0%	0%	1%	Feb	-1%	-1%	-1%	Mar	-1%	-1%	-2%	Apr	-2%	-2%	-2%	May	-2%	-2%	-2%	Jun	-1%	-1%	-1%	Data: Median: Nov: +2% Dec: +6% Jan: +2% Feb: -1% Mar: -4% Apr: -2% May:-1% June: -1% Effects: Higher flows in winter (Nov to Jan) could increase predation risk when the bulk of the eulachon run is migrating up the Columbia River.	Data: Percent Change by Month <table><tr><th>Month</th><th>25%</th><th>Med</th><th>75%</th></tr><tr><td>Nov</td><td>2%</td><td>2%</td><td>2%</td></tr><tr><td>Dec</td><td>1%</td><td>2%</td><td>4%</td></tr><tr><td>Jan</td><td>-2%</td><td>-2%</td><td>1%</td></tr><tr><td>Feb</td><td>0%</td><td>0%</td><td>0%</td></tr><tr><td>Mar</td><td>-1%</td><td>-1%</td><td>-1%</td></tr><tr><td>Apr</td><td>-2%</td><td>-2%</td><td>-2%</td></tr><tr><td>May</td><td>-2%</td><td>-2%</td><td>-2%</td></tr><tr><td>Jun</td><td>-1%</td><td>-1%</td><td>-2%</td></tr></table> Effects: Slightly higher flows in Nov to Dec; slight increase in predation risk to early run.	Month	25%	Med	75%	Nov	2%	2%	2%	Dec	1%	2%	4%	Jan	-2%	-2%	1%	Feb	0%	0%	0%	Mar	-1%	-1%	-1%	Apr	-2%	-2%	-2%	May	-2%	-2%	-2%	Jun	-1%	-1%	-2%	Data Outputs: Percent Change by Month <table><tr><th>Month</th><th>25%</th><th>Med</th><th>75%</th></tr><tr><td>Nov</td><td>-1%</td><td>-1%</td><td>0%</td></tr><tr><td>Dec</td><td>1%</td><td>1%</td><td>3%</td></tr><tr><td>Jan</td><td>0%</td><td>1%</td><td>3%</td></tr><tr><td>Feb</td><td>-1%</td><td>-2%</td><td>-2%</td></tr><tr><td>Mar</td><td>1%</td><td>1%</td><td>-1%</td></tr><tr><td>Apr</td><td>-2%</td><td>-2%</td><td>-2%</td></tr><tr><td>May</td><td>-1%</td><td>-1%</td><td>1%</td></tr><tr><td>Jun</td><td>-1%</td><td>-1%</td><td>1%</td></tr></table> See attached file for values. Effects of MO4 compared to NAA: Wet and average years similar to NAA (1% to 2% change). Dry years – no change or slightly lower risk in Feb to June, and slightly higher risk in Dec to Jan. In extremely dry years (99% exceedance), May outflows 10% higher than NAA, which could make them more susceptible to predation but tradeoff for higher flows could be beneficial? Early portion of the run may be	Month	25%	Med	75%	Nov	-1%	-1%	0%	Dec	1%	1%	3%	Jan	0%	1%	3%	Feb	-1%	-2%	-2%	Mar	1%	1%	-1%	Apr	-2%	-2%	-2%	May	-1%	-1%	1%	Jun	-1%	-1%	1%	Regarding flow - higher rainfall as opposed to snowmelt-driven flows cause higher turbidity which, as a rule, reduces predation due to visibility (Muir and Williams 2011)
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						susceptible to slightly higher predation risk than NAA. Such a slight change in flow will likely not cause an effect on the biological side. Notes: Need to re-look with water year types (with and without McNary measure triggered). Note - included text 6/10 on dry years.	
Adult Upstream Migration and Spawning							
Adult spawning migration: Water temperature influences run timing (NMFS, 2017). Eulachon are typically present in the Columbia River from 2°C to 10°C, with spawning triggered at 4°C.	Temp BON tailrace or below, dates of migration (2° to 10°C) and spawning (4°C) cues.	H&H and WQ Outputs: Running through the dataset, Date first dropped below 10°C, then 4° in each migration season. 10°C 4°C 01/02/11 11/14/11 12/22/11 11/23/12 01/01/13 11/11/13 12/09/13 11/13/14 01/09/15 11/20/15 12/30/15 (4.08°) Effects to Resource NAA: Temps in Columbia River (modeled Bonneville tailwater temps) would typically be conducive to trigger upstream migration by mid- to late-November, with the spawning trigger of 4°C occurring in late December/early January of each run year. Differing temperatures, from year to year, as well as the timing of high tides (NMFS, 2017) can affect timing and location of spawning. Notes: Present 4.4°-10°, spawn at about 6°C (WDFW and ODFW, 2001).	Data Outputs: Running through the dataset, Date first dropped below 10°C, then 4° in each migration season. 10°C 4°C 01/02/11 11/14/11 12/23/11 11/23/12 01/01/13 11/11/13 12/09/13 11/13/14 01/09/15 11/20/15 12/30/15 (4.26°) Effects of MO1 compared to NAA: Modeled dates of reaching migration and spawning trigger dates were either the same, or within a day of the NAA. Effects would be the same as NAA.	Data: Running through the dataset, Date first dropped below 10°C, then 4° in each migration season. 10°C 4°C 01/02/11 11/14/11 12/23/11 11/23/12 01/01/13 11/11/13 12/10/13 11/14/14 01/08/15 11/20/15 12/30/15 (4.33°) Effects: Same as MO1, all triggers within a day of NAA.	Data: Running through the dataset, Date first dropped below 10°C, then 4° in each migration season. 10°C 4°C 01/02/11 11/13/11 2/20/11 11/18/12* 12/31/12 11/09/13 12/09/13 11/13/14 01/08/15 11/18/15 12/30/15 (4.01°) *11/20 and 11/21 just barely over 10°C Effects: Within a day of NAA, same as NAA.	Data Outputs: Running through the dataset, Date first dropped below 10°C, then 4° in each migration season. 10°C 4°C 01/02/11 11/14/11 12/23/11 11/23/12 01/01/13 11/11/13 12/09/13 11/13/14 01/08/15 11/19/15 12/30/15 (4.29°) Effects of MO4 compared to NAA: Modeled dates of reaching migration and spawning trigger dates were either the same, or within a day of the NAA. Effects would be the same as NAA.	–
Adult migration barriers: Physical barriers can impede migration and limit available spawning habitat. BON is potential barrier. Upstream migration distance dependent on abundance, migration to Bonneville is rare, but	Presence of barrier, consider structural or spill measures for any potential effects.	H&H and WQ Outputs: Current configuration Spill Effects to Resource NAA: BON is near the upstream range of spawning, but could continue to impede access further upstream in years of very large eulachon runs. When passing through Bonneville	Data Outputs: S4: Modify upper ladder serpentine flow control ladder (vertical slot) S7: Turbine cooling water strainers? S8: Modify turbine intake bypass screens S9: Modify existing ladders (ramps, diffuser grating plating)	Data: Lamprey passage ladder modifications Effects: Same as NAA.	Data: Modify Bonneville ladder serpentine weir. Effects: Same as MO1.	Data Outputs: S7: Lamprey Passage Ladder Modifications Effects of MO4 compared to NAA: Same as NAA	NMFS 2010

Columbia River System Operations Environmental Impact Statement
Appendix E: Fish, Aquatic Macroinvertebrates, and Aquatic Habitat

Affected Environment Important Relationships/Criteria	Affected Environment Metric	Environmental Consequences NAA	Environmental Consequences MO1	Environmental Consequences MO2	Environmental Consequences MO3	Environmental Consequences MO4	References
may hinder migration or cause mortalities (mechanical stress in projects) in years of abundant runs. Eulachon can pass through the ship locks.		dam, some eulachon injury or mortality could continue. Notes: Only reach BON in very large run years. Mainstem spawning is about 50% of run, mostly lower River. Tributaries (Cowlitz/Lewis) are major spawning areas. No issues with river stage affecting these tributaries access. Note to writers: this is a very minor impact, but important to describe that it is minor.	Spill: Spring Block spill test 100 kcfs, 120%/115% spill; Summer spill 95 kcfs Effects of MO1 compared to NAA: Structural measures could allow eulachon to pass through the ladders more effectively. Notes: Team - the team didn't discuss structural or spill measures; could either of these affect the number of eulachon able to pass or the mortality/injury? Workshop Note: Previous matrices included potential river stage issues. Sue called Art 3/19/19 – he had brought them up for coho and not necessarily eulachon, but also checked with biologists from OR and WA and thought any access issues had already been addressed so this is not an issue. River stage issues deleted from this version.				
Substrate for mainstem spawning: need pea-sized gravel and coarse sand. Substrate can be affected by flows, particularly with changes in peak flows.	Peak flows at BON	H&H and WQ Outputs: Peak flows in June: mean monthly outflows in June: 295,706 Effects to Resource NAA: A portion of eulachon would continue mainstem spawning where appropriate substrate exists.	Data Outputs: 0.9% decrease in mean monthly outflows of median water year in June (June: 293,731) Effects of MO1 compared to NAA: Same as NAA.	Data: 1% decrease in Mean monthly outflows in June. Effects: Same as NAA.	Data: 1% decrease in Mean monthly outflows in June. Effects: Same as NAA.	Data Outputs: 1.1% decrease in mean monthly outflows of median water year in June (292,998 (-1.1%) Noted - in extremely dry years (99% exceedance) May flows 10% higher than NAA. Effects of MO4 compared to NAA: Similar to NAA. In very dry years, there would be more flow in May than under NAA, but little channel maintenance is likely occurring in these low flow years under any scenario.	Regarding flow - higher rainfall as opposed to snowmelt driven flows cause higher turbidity which as a rule reduces predation due to visibility (Muir and Williams, 2011)
Flow-migration timing: Low flows and temperature triggers for spawning, followed by timely freshet to disperse larvae during yolk sac survival period.	Time between temperature spawning trigger and freshet from summary hydrograph Columbia and Willamette flows	H&H and WQ Outputs: Spawn trigger date from above, compared to peak flow in Columbia and Willamette flows summary hydrograph for high (25%), Ave (50%) and Low (25%) flows. Difference calculated in days between those dates.	Data Outputs: Spawn trigger date from above, compared to peak flow in Columbia and Willamette flows summary hydrograph for high (25%), Ave (50%) and Low (25%) flows. Difference calculated in days between those dates.	Data: Spawn trigger date from above, compared to peak flow in Columbia and Willamette flows summary hydrograph for high (25%), Ave	Data: Spawn trigger date from above, compared to peak flow in Columbia and Willamette flows summary hydrograph for high (25%), Ave (50%) and Low (25%)	Data: Spawn trigger date from above, compared to peak flow in Columbia and Willamette flows summary hydrograph for high (25%), Ave (50%) and Low (25%)	–

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		Spawn Peak Trigger Flow Diff High (2011): 01/01/11 06/08 158 days Ave (2012): 12/22/11 06/08 168 days Low (2013): 01/01/13 06/06 156 days Extreme low: 05/19 Extreme low years, May mean monthly discharge = 216798 Discharge duration 90% exceedance = 217603 Discharge duration 90% exceedance = 190,088 Effects to Resource NAA: The NAA hydrograph maintains a spring peak freshet that is timed with the winter migration and spawning period to match the outmigration of larval eulachon with the freshet. Modeled temperatures and hydrology estimates 155 to 168 days from spawning trigger to peak of the freshet. Notes: Temperature triggers spawning. Staging in estuary waiting for right temp. Move up to adequate habitat. Deepwater spawning in mainstem; depth not as important.	Spawn Peak Trigger Flow Diff High (2011): 01/02/11 06/08 157 days Ave (2012): 12/23/11 06/05 164 days Low (2013): 01/01/13 06/07 157 days Effects of MO1 compared to NAA: Same as NAA. Notes:	(50%) and Low (25%) flows. Difference calculated in days between those dates. Spawn Peak Trigger Flow Diff High (2011): 01/02/11 06/08 157 days Ave (2012): 12/23/11 06/05 164 days Low (2013): 01/01/13 06/07 157 days Effects: Same as NAA.	flows. Difference calculated in days between those dates. Spawn Peak Trigger Flow Diff High (2011): 01/01/11 06/08 158 days Ave (2012): 12/22/11 06/05 166 days Low (2013): 01/01/13 06/07 157 days Effects: Same as NAA.	flows. Difference calculated in days between those dates. Spawn Peak Trigger Flow Diff High (2011): 01/02/11 06/08 157 days Ave (2012): 12/23/11 06/05 164 days Low (2013): 01/01/13 06/07 157 days Extreme low: 05/17 Note: in extremely low (99%) Mean monthly flows in May – 237997, about 21,200 cfs (9%) higher than NAA. May discharge duration 90% exceedance – 239435 (+21,832 – 9%) June discharge duration 90% exceedance = 2-6,980 (16,892 – 8%) Effects: In most water year types, the timing of spawning triggers and the peak hydrograph would be similar to the NAA. In extremely dry years (the lowest 1%), the freshet would begin a couple of days earlier, but would be sustained longer. Driest 10% of years the discharge duration is sustained about 8% to 9% higher in May and June, which may increase larval dispersal downstream in very low water years.																																					
Juvenile Growth and Survival																																											
Size of plume affects early ocean survival. More plume distributes larvae further out into the ocean (more flow=larger plume=better	Columbia and Willamette flows. Mean monthly flows (Feb to May) in median, 25%, and 75% exceedance. If potential effect, estimate plume size.	H&H and WQ Outputs: <table><tr><th>Month</th><th>25%</th><th>Med</th><th>75%</th></tr><tr><td>Feb</td><td>318765</td><td>266760</td><td>216851</td></tr><tr><td>Mar</td><td>282091</td><td>232780</td><td>195023</td></tr><tr><td>Apr</td><td>307054</td><td>260370</td><td>210833</td></tr></table>	Month	25%	Med	75%	Feb	318765	266760	216851	Mar	282091	232780	195023	Apr	307054	260370	210833	Data Outputs: <table><tr><th colspan="4">25%</th></tr><tr><th>Month</th><th>Flow</th><th>Change</th><th>Percent Change</th></tr><tr><td>Feb</td><td>316274</td><td>-2491</td><td>-1%</td></tr></table>	25%				Month	Flow	Change	Percent Change	Feb	316274	-2491	-1%	Data: Feb: Same as NAA. Mar: -3% Apr: -2% May: -1%	Data: Feb: Same as NAA. Mar: -1% Apr: -2% May: -2%	Data Outputs: <table><tr><th colspan="4">25%</th></tr><tr><th>Month</th><th>Flow</th><th>Change</th><th>Percent</th></tr></table>	25%				Month	Flow	Change	Percent	Outflow plume relationship: Antonio Baptista, Oregon HSU Langness and Heironimus, personal communication Indicators: Joint staff reports – Laura send link
Month	25%	Med	75%																																								
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distribution). Higher outflows from BON = more flume.		May	366718	314137	274443	Mar	280677	-1414	-1%	Effects: Similar to MO1, slightly less outflow in spring months could result in slightly less distribution of larvae compared to NAA.	Effects: Similar to MO1, slightly less outflow in spring months could result in slightly less distribution of larvae compared to NAA.				Chan		
		Effects to Resource NAA: Median flow years and above would continue to relate to better survival, based on larger plume and faster passage through the estuary. Notes: Smaller plume tends to push them southward, closer inland; larger plume pushes northward and further. Spawn Jan to Mar. Dispersal in Feb to May. Relationship – big plume or don’t. At very low flows, they don’t get pushed out of estuary at all. (Tributaries below BON also influence.)				Apr	301154	-5900	-2%			Feb	315882	-2883	-1%		
						May	361290	-5428	-2%			Mar	284344	2253	1%		
						Median						Apr	300980	-6074	-2%		
		Month	Flow	Change	Percent Change	Feb	262834	-3927	-1%			May	361427	-5291	-1%		
		Feb	262834	-3927	-1%							Median					
		Mar	231161	-1620	-1%	Month	Flow	Change	Percent Change				Flow	Chan	Perce		
		Apr	255722	-4648	-2%	Feb	214469	-2382	-1%			nt					
		May	308143	-5994	-2%	Mar	192116	-2907	-2%			Chan	Feb	262696	-4064		-2%
						Apr	207704	-3129	-2%			ge	Mar	234927	2146		1%
				May	269430	-5013	-2%	ge	Apr	255136	-5233	-2%					
				75%								ge	May	310032	-4104	-1%	
				Month	Flow	Change	Percent Change					75%					
				Feb	214469	-2382	-1%						Flow	Chan	Perce		
				Mar	192116	-2907	-2%					Feb	213124	-3727	-2%	nt	
				Apr	207704	-3129	-2%					Mar	193961	-1063	-1%	Chan	
				May	269430	-5013	-2%					Apr	207002	-3831	-2%	ge	
												May	277378	2934	1%		
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Affected Environment Important Relationships/Criteria	Affected Environment Metric	Environmental Consequences NAA	Environmental Consequences MO1	Environmental Consequences MO2	Environmental Consequences MO3	Environmental Consequences MO4	References																																																																																												
						2% decrease in Feb to Apr, up to 10% increase in May. Increased flows in May of dry years could help with distribution of larvae. Notes: Refer to size of the plume. Variable plume size, consider flows at site further down from BON. Don't have flow data there, but the team does have BON plus Willamette. Response – Team – found out there are recorded flows at Columbia and Willamette, and adjusted the metrics.																																																																																													
Freshwater inputs to the nearshore ocean environment can affect the planktonic food supply and other processes important food supply and other processes important to larval eulachon. Decreased freshwater input may lead to lower survival.	Freshwater inputs – Columbia and Willamette flows, Apr to Jul	<table><tr><td colspan="4">H&H and WQ Outputs:</td></tr><tr><th>Month</th><th>25%</th><th>Med</th><th>75%</th></tr><tr><td>Apr</td><td>307054</td><td>260370</td><td>210833</td></tr><tr><td>May</td><td>366718</td><td>314137</td><td>274443</td></tr><tr><td>Jun</td><td>390625</td><td>319041</td><td>256963</td></tr><tr><td>Jul</td><td>264978</td><td>216458</td><td>165721</td></tr><tr><td colspan="4">Effects to Resource NAA: Relatively low freshwater inputs into the nearshore environment would continue to moderately limit plankton food supply for larval eulachon in the Apr to Jul period. Notes: From recovery plan. (From Amy: helpful to clarify that larval survival decreases when there is a mish-mash of planktonic food supply, environmental ocean conditions, and eulachon larvae. Results from decrease in primary productivity).</td></tr></table>	H&H and WQ Outputs:				Month	25%	Med	75%	Apr	307054	260370	210833	May	366718	314137	274443	Jun	390625	319041	256963	Jul	264978	216458	165721	Effects to Resource NAA: Relatively low freshwater inputs into the nearshore environment would continue to moderately limit plankton food supply for larval eulachon in the Apr to Jul period. Notes: From recovery plan. (From Amy: helpful to clarify that larval survival decreases when there is a mish-mash of planktonic food supply, environmental ocean conditions, and eulachon larvae. Results from decrease in primary productivity).				<table><tr><td colspan="4">Data Outputs:</td></tr><tr><td colspan="4">Percent Change</td></tr><tr><td>Month</td><td>25%</td><td>Med</td><td>75%</td></tr><tr><td>Apr</td><td>-3%</td><td>-2%</td><td>-2%</td></tr><tr><td>May</td><td>-2%</td><td>-2%</td><td>-2%</td></tr><tr><td>Jun</td><td>-1%</td><td>-1%</td><td>-1%</td></tr><tr><td>Jul</td><td>-2%</td><td>-1%</td><td>0%</td></tr><tr><td colspan="4">Effects of MO1 compared to NAA: Very small (1% to 2%) reduction in freshwater inputs could potentially result in lower plankton availability for larval eulachon food supply, but likely unmeasurable. Notes: No data to quantify a relationship, but could potentially affect.</td></tr></table>	Data Outputs:				Percent Change				Month	25%	Med	75%	Apr	-3%	-2%	-2%	May	-2%	-2%	-2%	Jun	-1%	-1%	-1%	Jul	-2%	-1%	0%	Effects of MO1 compared to NAA: Very small (1% to 2%) reduction in freshwater inputs could potentially result in lower plankton availability for larval eulachon food supply, but likely unmeasurable. Notes: No data to quantify a relationship, but could potentially affect.				Data: Apr: -2% May: -2% Jun: -1% Jul: Same as NAA. Effects: Very small (1% to 2%) reduction in freshwater inputs could potentially result in lower plankton availability for larval eulachon.	Data: Apr: -2% May: -2% Jun: -1% Jul: -2% Effects: Very small (1% to 2%) reduction in freshwater inputs could potentially result in lower plankton availability for larval eulachon.	<table><tr><td colspan="4">Data Outputs:</td></tr><tr><td colspan="4">Percent Change</td></tr><tr><td>Month</td><td>25%</td><td>Median</td><td>75%</td></tr><tr><td>Apr</td><td>-2%</td><td>-2%</td><td>-2%</td></tr><tr><td>May</td><td>-1%</td><td>-1%</td><td>1%</td></tr><tr><td>Jun</td><td>-1%</td><td>-1%</td><td>1%</td></tr><tr><td>Jul</td><td>-2%</td><td>0%</td><td>4%</td></tr><tr><td colspan="4">Effects of MO4 compared to NAA: Very small (1% to 2%) reduction in freshwater inputs could potentially result in lower plankton availability for larval eulachon.</td></tr></table>	Data Outputs:				Percent Change				Month	25%	Median	75%	Apr	-2%	-2%	-2%	May	-1%	-1%	1%	Jun	-1%	-1%	1%	Jul	-2%	0%	4%	Effects of MO4 compared to NAA: Very small (1% to 2%) reduction in freshwater inputs could potentially result in lower plankton availability for larval eulachon.				NMFS 2017
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Turbidity – relationships not clear. Higher turbidity (Jan-Mar) may provide protection from predators, but may hinder migration.	Turbidity qual.	<table><tr><td colspan="4">H&H and WQ Outputs:</td></tr><tr><td colspan="4">Qual baseline turbidity from water quality.</td></tr></table>	H&H and WQ Outputs:				Qual baseline turbidity from water quality.				<table><tr><td colspan="4">Data Outputs:</td></tr><tr><td colspan="4">No change to turbidity.</td></tr></table>	Data Outputs:				No change to turbidity.				Data: Same as NAA. Effects: Same as NAA.	Data: No change. Effects: No change.	<table><tr><td colspan="4">Data Outputs:</td></tr><tr><td colspan="4">No change.</td></tr><tr><td colspan="4">Effects of MO4 compared to NAA: No change.</td></tr></table>	Data Outputs:				No change.				Effects of MO4 compared to NAA: No change.				No citation provided, and not consistent with recovery plan that references decreased spring turbidity compared to historical. Text document cites recovery plan info.																																																																
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Changes in flow can change the location of the saltwater/ freshwater interface important to eulachon feeding.	Flow at BON, summary hydrograph.	Saltwater wedge is highly variable (check with Olaf on relationship). Wedge is probably no affecting them directly, but another measurement of flow. (Don't write up as an effect. Keep notes here.) There are	<table><tr><td colspan="4">Data Outputs:</td></tr><tr><td colspan="4">Amy note on plume and productivity. Oregon State University website includes description of Columbia River bringing buoyant freshwater to the</td></tr></table>	Data Outputs:				Amy note on plume and productivity. Oregon State University website includes description of Columbia River bringing buoyant freshwater to the				–	–	–	Olaf provide website citation for saltwater wedge (see eulachon). From Amy: http://mixing.coas.oregonstate.edu/research/river_plumes/. Structure and dynamics of																																																																																				
Data Outputs:																																																																																																			
Amy note on plume and productivity. Oregon State University website includes description of Columbia River bringing buoyant freshwater to the																																																																																																			

Data Outputs:			
No change to turbidity.			

Data: Same as NAA.
Effects:
Same as NAA.Data: No change.
Effects:
No change.

Data Outputs:			
No change.			

Effects of MO4 compared to NAA:
No change.

No citation provided, and not consistent with recovery plan that references decreased spring turbidity compared to historical. Text document cites recovery plan info.

Columbia River System Operations Environmental Impact Statement
Appendix E: Fish, Aquatic Macroinvertebrates, and Aquatic Habitat

Affected Environment Important Relationships/Criteria	Affected Environment Metric	Environmental Consequences NAA	Environmental Consequences MO1	Environmental Consequences MO2	Environmental Consequences MO3	Environmental Consequences MO4	References
		numerous estuary studies (Bottom, Simenstad, Weitkamp, etc.) showing abundance of zooplankton and forage fish in the estuary in relation to salinity and other factors. A top one couldn't be identified for eulachon, but the team can easily cover estuary productivity in general. Note: this relationship is more relative to green sturgeon.	Pacific Ocean, along with dissolved silicate and iron.				the Columbia River tidal plume front.
Increased barge traffic could increase predation. Structures could change Pinniped behavior and predation.	–	–	Data Outputs: No change to barge traffic. No changes to pinniped behavior note. Effects of MO1 compared to NAA: Same as NAA.	Data: No change to barge traffic. Effects: Same as NAA.	Data: No change to barge traffic (T. Teed email).	Data Outputs: No change to barge traffic. No changes to pinniped behavior noted. Effects of MO4 compared to NAA: Same as NAA.	NMFS, 2017

Howell, 2001

Kilcher and Nash. 2010. Structure and dynamics of the Columbia River tidal plume front. J. Geophys. Res., 115, C05S90.

Muir and Williams, 2011

National Marine Fisheries Service, 2017. Recovery Plan for the Southern Distinct Population Segment of Eulachon (Thaleichthys pacificus). National Marine Fisheries Service, West Coast Region, Protected Resources Division, Portland, OR, 97232. September 2017.

National Marine Fisheries Service, 2010. Status Review Update for Eulachon in Washington, Oregon, and California. January 21, 2010. 443 pp.

Washington Department of Fish and Wildlife and Oregon Department of Fish and Wildlife, 2001. Washington and Oregon Eulachon Management Plan. WDFW, Ridgefield, WA.

3.7.2 Green Sturgeon

Table 3-65. Green Sturgeon Qualitative Effects Analysis Matrix

Affected Environment Important Relationships/Criteria	Affected Environment Metric	Environmental Consequences NAA	Environmental Consequences MO1	Environmental Consequences MO2	Environmental Consequences MO3	Environmental Consequences MO4	Notes
Estuary Occupation	Greens primarily transient, use fall/summer in Columbia River. Not considered spawning habitat. Seen evidence of green sturgeon young-of-year at Bonneville (note from Amy that cited paper describes a single young-of-year in the Columbia River), operations that affect white sturgeon probably apply, limited, to greens as well. The young-of-year were Northern DPS. Southern DPS is Sacramento, Northern in elsewhere. Columbia typically dominated by Southern (listed). 80% southern in most years. Estuary is critical to greens. Diet, prey availability, to grow and reproduce.						
Temperatures in the estuary cue the arrival in spring and departure of green sturgeon in the fall. 15°C in the estuary (use as trigger arrival, but based on differential to ocean temperature).	Temperatures at BON to Warrendale: index BON tailwater temperature, extended year set, date first reached 15°C in spring, then drop below 15°C in fall.	Data Outputs: 2011 (HF/LT): 06/21-10/20 2012 (AF/LT): 06/02 (1 day, then again on 6/16)-10/19 2013 (LF/AT): 06/03-10/12 2014 (AF/AT): 05/23-10/26 2015 (LF/HT): 05-19-10/25 Effects to Resource: Currently arrive about June, leave about Sep/Oct. Some years, as early as May and as late as Dec. Currently supports adequate rearing conditions for green sturgeon. Expected to continue. NAA Notes: Temperatures will vary greatly from BON down, ocean affects.	Data Outputs: 2011: 06/21-10/20 2012: 06/02 (1 day, then again on 6/16) – 10/19 2013: 06/04 (06/03 was 14.99°C – 10/12 2014: 05/23 – 10/26 (same as NAA 2015: 05/19 – 10/26 (1 day later) Effects to Resource: Same as NAA. Notes: NA	Data Outputs: Water quality states no change to water temperature sin lower river. Effects to Resource: Expect same as NAA. Notes: NA	Data Outputs: 2011: 06/21 – 10/19 (1 day earlier) 2012: 06/17 (later than NAA, 0.3° to 0.5° cooler) – 10/18 (1 day earlier) 2013: 06/04 (06/03 was 14.99°C – 10/12 2014: 05/23 – 10/26 2015: 05/19 – 10/25 Effects to Resource: Similar to NAA. Notes: NA	Data Outputs: 2011: 06/21 – 10/20 2012: 06/16 (6/2 was 14.99°C, then dropped) 2013: 06/04 (06/03 was 14.89°C) – 10/11 (1 day earlier) 2014: 05/23 – 10/26 2015: 05/20 (05/19 was 14.95°C) – 10/25 Effects to Resource: Same as NAA. Notes: NA	Moser and Lindley, 2007 Schreier et al., 2016 (sent to Sue)

Affected Environment Important Relationships/Criteria	Affected Environment Metric	Environmental Consequences NAA	Environmental Consequences MO1	Environmental Consequences MO2	Environmental Consequences MO3	Environmental Consequences MO4	Notes							
Changes in flow can change the location of the saltwater/ freshwater interface that is important to green sturgeon feeding.	Flows: Columbia plus Willamette, June to Oct.	Data Outputs:				Data Outputs:				Data Outputs:				—
		Month	1%	25%	Median		Percent Change				Percent Change			
		Oct	185362	119899	10814	Month	25%	Median	75%	Month	25%	Med	75%	
		Jun	619863	389625	31894	Oct	0%	0%	0%	Oct	-3%	-4%	-4%	
		Jul	365538	264978	21649	Jun	-1%	-1%	-1%	Jun	-1%	-1%	1%	
		Aug	246255	180337	15891	Jul	-2%	-1%	0%	Jul	-2%	0%	4%	
		Sep	175464	121950	11148	Aug	-4%	-5%	-5%	Aug	-4%	-4%	-5%	
						Sep	-1%	-1%	-2%	Sep	-3%	-6%	-9%	
						Effects to Resource:				Effects to Resource:				
						Slight decrease (4% to 5%) in flows could result in slight changes in the location of the saltwater wedge in August (pushed further upstream). The effects to green sturgeon are not well understood.				Slightly different flows could change the location of the saltwater wedge, but likely immeasurably. Further upstream in Jun, Aug, Sep, Oct, and further downstream in Jul as compared to the NAA. Fluctuation of wedge (further downstream in Jul, further upstream in Aug to Oct) could be an additional stressor, but effect not known.				
						Notes:				Notes:				
						NA				NA				

Changes in estuary temperatures could alter productivity and food sources in the estuary.	Temperature at BON to Warrendale: index BON tailwater temperature, extended year set, average monthly temperature, May to Oct.	Data Outputs:				Data Outputs:			Data Outputs: Water states quality no change to water temperatures in lower river. Will check data. Effects to Resource: Same as NAA. Notes: NA	Data Outputs:			Data Outputs:			Moser and Lindley, 2007.
		2011 (HF/LT)		2012 (AF/LT)		2011 (HF/LT)				2011 (HF/LT)			2011 (HF/LT)			
		May	11.79	May	12.52	May	NAA	MO1		May	NAA	MO3	May	NAA	MO4	
		Jun	14.73	Jun	15.38		11.79	11.79			11.79	11.81		11.79	11.77	
		Jul	16.72	Jul	18.83	Jun	14.73	14.74		Jun	14.73	14.61	Jun	14.73	14.72	
		Aug	20.16	Aug	20.71	Jul	17.82	17.82		Jul	17.82	17.87	Jul	17.82	17.82	
		Sep	18.56	Sep	18.56	Aug	20.16	20.15		Aug	20.16	20.19	Aug	20.16	20.17	
		Oct	15.58	Oct	15.03	Sep	19.56	19.59		Sep	19.56	19.51	Sep	19.56	19.58	
						Oct	15.58	15.61		Oct	15.58	15.5	Oct	15.58	15.59	
		2013 (LF/AT)		2014 (AF/AT)		2012 (AF/LT)	-	-		2012 (AF/LT)			2012 (AF/LT)			
		May	13.77	May	13.19	May	NAA	MO1		May	NAA	MO3	May	NAA	MO4	
		Jun	16.66	Jun	16.59		12.52	12.72			12.52	13.21		12.52	12.67	
		Jul	20.37	Jul	20.73	Jun	15.38	15.29		Jun	15.38	15.17	Jun	15.38	15.25	
		Aug	21.76	Aug	22.14	Jul	18.81	18.76		Jul	18.81	18.81	Jul	18.81	18.68	
		Sep	20.19	Sep	19.54	Aug	20.77	20.71		Aug	20.77	20.71	Aug	20.77	20.75	
		Oct	14.35	Oct	16.32	Sep	18.66	18.70		Sep	18.66	18.58	Sep	18.66	18.64	
						Oct	15.03	15.03		Oct	15.03	14.86	Oct	15.03	14.98	
		2015 (LF/HT)				2013 (LF/AT)	-	-		2013 (LF/AT)	-	-	2013 (LF/AT)	-	-	
		May			14.61	May	NAA	MO1		May	NAA	MO3	May	NAA	MO4	
		Jun			19.69		13.77	13.80			13.77	13.76		13.77	13.72	
		Jul			21.95	Jun	16.66	16.69		Jun	16.66	16.73	Jun	16.66	16.69	
		Aug			21.45	Jul	20.37	20.37		Jul	20.37	20.44	Jul	20.37	20.44	
		Sep			18.60	Aug	21.76	21.72		Aug	21.76	21.71	Aug	21.76	21.76	
		Oct			16.05	Sep	20.19	20.21		Sep	20.19	20.15	Sep	20.19	20.16	
		Effects to Resource: Would continue to provide a good food source relative to their home estuary; green sturgeon would continue to use the estuary as transient habitat.				Oct	14.35	14.35		Oct	14.35	14.2	Oct	14.35	14.42	
		Notes: Estuary provides large food source as related to Sacramento (related to why greens migrate out of their own estuary into the Columbia River). Opportunistic predators, generally well-supported by current conditions.				2014 (AF/AT)	-	-		2014 (AF/AT)	-	-	2014 (AF/AT)	-	-	
						May	NAA	MO1		May	NAA	MO3	May	NAA	MO4	
							13.19	13.29			13.19	13.33		13.19	13.33	
						Jun	16.55	16.53		Jun	16.55	16.45	Jun	16.55	16.51	
						Jul	20.73	20.70		Jul	20.73	20.84	Jul	20.73	20.65	
						Aug	22.14	22.14		Aug	22.14	22.14	Aug	22.14	22.16	
						Sep	19.54	19.55		Sep	19.54	19.41	Sep	19.54	19.50	
						Oct	16.32	16.38		Oct	16.32	16.24	Oct	16.32	16.36	
						2015 (LF/HT)	-	-		2015 (LF/HT)	-	-	2015 (LF/HT)	-	-	
						May	NAA	MO1		May	NAA	MO3	May	NAA	MO4	
							14.61	14.61			14.61	14.72		14.61	14.52	
						Jun	19.69	19.76		Jun	19.69	19.84	Jun	19.69	19.69	
						Jul	21.95	21.99		Jul	21.95	22.07	Jul	21.95	22.24	
						Aug	21.45	21.59		Aug	21.45	21.45	Aug	21.45	21.96	
						Sep	18.60	18.59		Sep	18.6	18.48	Sep	18.60	18.52	

Affected Environment Important Relationships/Criteria	Affected Environment Metric	Environmental Consequences NAA	Environmental Consequences MO1				Environmental Consequences MO2				Environmental Consequences MO3				Environmental Consequences MO4				Notes
			Oct	16.05	16.12						Oct	16.05	15.98		Oct	16.05	16.02		
			Effects to Resource: Average monthly temperatures for all months in the representative flow/air temperature types were within 2/10ths of a degree from the NAA. Effect to green sturgeon would be the same as NAA. Notes: NA								Effects to Resource: Similar to NAA except May 2012 (AF/LT) 0.69° warmer than NAA. Notes: NA				Effects to Resource: All average monthly temperatures were within 2/10ths of the NAA, with the exception of Jul and Aug in low flow, high air temperature years (such as 2015); in this case, the MO4 mean monthly was 0.29°C (July) and 0.50°C higher than NAA. The biological effect would likely be the same as NAA. Notes: Team – would 0.5° difference be measurable to the relationship of productivity and food sources?				
Channel maintenance operations can affect green sturgeon through displacement and disruption of food sources.	—	Data Outputs: NA Effects to Resource: Check if CRSO would affect any channel maintenance operations. If not, keep notes here for cumulative effects. Notes: Possible displacement, disruption of food, etc. Parsley et al., white sturgeon fidelity of habitat (not green sturgeon).	Data Outputs: NA Effects to Resource: NA – keep notes for cumulative effects. Notes: Any alternatives potentially result in placement of more material downstream of BON and, therefore, require additional dredging.				Data Outputs: NA Effects to Resource: NA Notes:				Data Outputs: Similar to NAA. Effects to Resource: Same as NAA. Notes:				Data Outputs: Similar to NAA. Dry years slightly warmer and higher summer flows may influence slightly, but likely not a population level effect. Effects to Resource: NA Notes: None				NA

Affected Environment Important Relationships/Criteria	Affected Environment Metric	Environmental Consequences NAA	Environmental Consequences MO1	Environmental Consequences MO2	Environmental Consequences MO3	Environmental Consequences MO4	Notes
Coastal bays and estuaries, including the Columbia River estuary, are used for feeding, and these food sources could be negatively affected by the shift from native to non-native fish assemblages.	Qualitative, trend of native versus non-native assemblages.	Data Outputs: N/A Effects to Resource: Coordinate effects with fish community. The estuary would continue to provide food sources for transitory green sturgeon, but this food source may diminish over time if the fish community shifts from native to non-native dominance. Notes: Greens primarily transient, use fall/summer in Columbia River. Not considered spawning habitat. Seen evidence of green sturgeon young-of-year at BON, ops that affect white sturgeon probably apply, limited, to greens as well. The young-of-year were Northern DPS. Southern DPS is Sacramento, Northern in elsewhere. Columbia typically dominated by Southern. (listed). 80% southern in most years. Estuary is critical to greens. Diet, prey availability, to grow and reproduce.	Data Outputs: Similar to NAA. Effects to Resource: Similar to NAA.	Data Outputs: Similar to NAA. Effects to Resource: Same as NAA. Notes:	Data Outputs: Effects to Resource: Notes:	Data Outputs: Effects to Resource: Same as NAA. Notes: None	WDFW Reports NMFS, 2018

Moser, Mary L., and Steven T. Lindley. Use of Washington estuaries by subadult and adult green sturgeon. Environ Biol Fish (2007) 79:243–253.

National Oceanic and Atmospheric Administration, National Marine Fisheries Service, 2018. Recovery Plan for the Southern Distinct Population Segment of North American Green Sturgeon (Acipenser medirostris). National Marine Fisheries Service, Sacramento, CA.

3.7.3 Pacific Lamprey

Table 3-66. Lamprey Qualitative Effects Analysis Matrix

Affected Environment Important Relationships / Criteria	Affected Environment Metric	Environmental Consequences NAA	Environmental Consequences MO1	Environmental Consequences MO2	Environmental Consequences MO3	Environmental Consequences MO4	Notes
Adult Mainstem Passage							
Mainstem dams can inhibit upstream migration to spawning areas. The drivers for this effect are the following: 1) lower fishway sections, slow velocities, and turbulence can cause turnarounds; and	Dam passage efficiency, dam to dam escapement, counts index at each dam.	A portion of lamprey that enter the Columbia River and attempt to move upstream are able to pass the dams and move into desired spawning areas upstream. The proportion depends on location in the basin; further upstream = more dams	Lower spill than NAA, potentially change routes of passage in lower river. In the Snake River, potentially better passage with less spill. Bonneville -Getting fish into the fishway (S6 -expand network of LPS to bypass impediments in	Effects are the same as for MO1. DATA: S6: Lamprey passage structures S9: Lamprey passage ladder modifications Decreased spill and TDG – see below relationships.	The Columbia River projects would have the same effects as for MO1. Long-term Snake River: lamprey passage at Snake River dam locations would be likely mostly supported with current configurations of feasibility level	The effects would be the same as for MO1. DATA: S5: Lamprey Passage Structures S7: Lamprey Passage Ladder Modifications	Keefer Corps summary reports CRITFC carcass survey grad student (Siena) Clabough et al., 2015 Keefer et al., 2012 Corps, 2019

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Appendix E: Fish, Aquatic Macroinvertebrates, and Aquatic Habitat*

Affected Environment Important Relationships / Criteria	Affected Environment Metric	Environmental Consequences NAA	Environmental Consequences MO1	Environmental Consequences MO2	Environmental Consequences MO3	Environmental Consequences MO4	Notes
2) velocity and structural issues in the ladders (angles, corners, flow concentrations, etc.) cause difficulty.		encountered. Attrition through the system leads to fewer and fewer lamprey able to make it up further into the system. Dams reduce access to desired spawning locations. Some mitigation of lamprey passage effects occurs by translocation programs. Distribution effects, limiting total population size, may displace spawning individuals. Reduced distribution and abundance reduces attraction pheromone cues. Reduced ecosystem/food web effects (lamprey transfer nutrients upstream (Dunkle, 2017 in McIlraith, 2017). Adult lamprey passage metrics are expected to remain consistent in near future and improve incrementally as conventional fishway structures and operations are modified and LPSs are installed. DATA: Median Dam passage efficiencies across all study years, 1997-2010 (Keefer et al. 2012)* BON = 44% (n=10 years) TDA = 68% (n=10 years) JDA = 46% (n=6 years) MCN = 64%/81% (MCN tagged fish/BON tagged fish, n=6 years) Dam passage efficiency, 2014 (Clabough et al., 2015): “Dam passage efficiency (the number of tagged lamprey that passed the dam divided by the number that approached a fishway) were 49-52% (n = 453-473 approached) at Bonneville Dam (first number excludes 20 recaptured fish). Dam passage efficiency was 47% (n = 157) at The Dalles Dam, 83% (n = 48) at John Day Dam, and 100% (n = 7) at McNary Dam.” 2015: Lower Snake Dams	existing ladders, and improvements to ladders S9) would be substantial improvement to improve percentage of fish getting into the fish ladders at Bonneville. LPS probably more benefit than ladder improvements because the lamprey do not make it into the structures at Bradford Island fishway. For context, improvements at JDA ladders to improve lamprey entrance into fishways resulted in increased dam passage efficiency from 46% to 83% (Clabough et al., 2015). Dynamics at each dam are very different so cannot infer directly across, but do see improvements in overall dam passage efficiency with improvements in ladder entrance efficiency. Bonneville is a large structure and requires more improvements on the smaller scale to make a difference on the overall dam passage efficiency; likely improvement would be less. S4: Modify serpentine section - would also improve passage efficiency for lamprey. TDA - North ladder LPS - have passage there, incremental benefit but not as drastic as BON. JDA - LPS on south and extension on north would continue to moderately improve overall dam passage efficiency incrementally (has already improved in NAA). S3: would improve lamprey passage issues at the adult trap (allow to pass when not trapping). S5: Cooler water in the ladders; LMN and IHR. This has been done at LGO and IHR and was successful in cooling the ladder; would be expected to benefit		sketches. Issues could arise from lamprey coming up the structure side and getting caught with a high velocity barrier at concrete corners at high flows. The armoring substrate would be riprap, and would require burst swimming speeds over riprap. In some locations, the velocities could be limiting just upstream but likely a relic of previous deposition that would be flushed through with a dam breach. Early migrants could see velocities above their burst speeds; considerations would be made in design phase. Passage through dam breaches would be better passage than in the NAA ladders. DATA: Lower Columbia dams: S7: Lamprey Passage Structures S10: Lamprey Passage Ladder Modifications For the Dam breach on Snake River measure, see Hydraulic Engineering presentation of site configuration and hydraulics. NOTES: Mesa et al. (2003) state 2.6 fps swim speed for lamprey. The max burst swimming speed is 8.2 to 9.8 fps from Kiefer et al., 2010. In a white paper on adult passage, 7.0 fps is the burst swimming speed. 3.0 fps is regular swim speed obtained by averaging over different studies. Snake timing - late May leading, mostly in June, Jul, Aug. Overwintering fish may be trying to move sooner.		McIlraith ,2017 (BPA Report 2008-524-00 2016 Annual Report) CRITFC 2011.Tribal Pacific Lamprey Restoration Plan for the Columbia River Basin.

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		(Stevens et al., 2016) IHR = 47% LMO = 68% LGO = 41% LGR = 67% NOTES: There is uncertainty with escapement counts, but they are used as an index. Attrition occurs through the system. Tag effects in studies likely underestimate passage success (size effect, larger ones tend to make it further; may be somewhat attributed to tag burden effect), but the relationship is seen in PIT tagged (not radio-tagged) fish as well. Data for upstream projects is less certain due to small sample size. **Structural issues at BON: add more detail on structural issues. This is more important at Bonneville. **Cumulative effects/attrition occur through multiple dams. Calculation – 1. NOAA/Uofl, Keefer – general migration report. Percentage released below BON that make it to The Dalles, John Day. Check mainstem implementation plan or FWS assessment. Estimate based on RT data in different fishways. Keefer “bottleneck exercise” combined with observed collection efficiencies. Range of anticipated collection and potential benefits. Use as a percentage. The NWW sample sizes are so small it is hard to make an estimate on previous studies. The wintering over strategy makes it hard to extrapolate as well.	lamprey. S9: Mods to LMN - diffuser grate plating. Has been done at all other ladders except LMN and demonstrated slight benefits to lamprey passage. Additional work at LMN would increase this benefit incrementally. Weir caps to entrances - would assist fish into adult ladders (reduce issues with right angles) (Moser et al., 2003 and Daigle et al., 2005). Overall passage efficiency would likely improve incrementally over time as individual modifications were implemented. NOTES: Improved dam passage efficiency in 2014 at JDA (83% in 2014 vs. a historic median of 46%) suggests that extensive incorporation of lamprey passage features in FCRPS BiOp-mandated JDA North Ladder improvements in the lower and upper fishway segments (completed between 2010 and 2013) likely resulted in meaningful improvements to dam passage efficiency. Studies in 2018-2019 provide the opportunity to verify improved passage at JDA. The number of BON-tagged lamprey that approach JDA are small, so these metrics are based on relatively small sample sizes. Each structural measure is intended to increase dam passage efficiency. Each project is unique: BON - WA shore fishway LFS expected to be substantial improvement, wanted to improve entrance efficiency, but not effective. Bottleneck at BON is getting fish into the fishway (about 50% approach didn't make it into fishway).				

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Translocation programs in the basin help mitigate for dam passage impediments.	Number of translocated lamprey.	Three of the CRITFC member tribes participate in translocation, the NPT, CTUIR, and YN. Translocation was implemented to immediately address the threat that lack of passage poses for Pacific lamprey and return lamprey to high quality habitat where they were once abundant but were extirpated or near extirpated. Translocation has resulted in successful spawning and increases in larval lamprey density, which in turn provides attraction to adult migrating lamprey. Between 2013 and 2018, total collections of adult lamprey for tribal translocation programs from all three dams combined is >17,100 adult lamprey. Numbers of translocated lamprey have increased from 1,480 in 2013 to 4,738 in 2018. Lamprey translocation numbers would continue to increase accordingly with population increases. DATA: <table><tr><td>2013:</td><td>BON</td><td>TDA</td><td>JDA</td></tr><tr><td></td><td></td><td>Total</td><td></td></tr><tr><td>2013:</td><td>714</td><td>304</td><td>462</td></tr><tr><td></td><td></td><td>1480</td><td></td></tr><tr><td>2014:</td><td>762</td><td>793</td><td>642</td></tr><tr><td></td><td></td><td>2197</td><td></td></tr><tr><td>2015:</td><td>867</td><td>1110</td><td>875</td></tr><tr><td></td><td></td><td>2852</td><td></td></tr><tr><td>2016:</td><td>645</td><td>784</td><td>1018</td></tr><tr><td></td><td></td><td>2447</td><td></td></tr><tr><td>2017:</td><td>1107</td><td>1588</td><td>742</td></tr><tr><td></td><td></td><td>3437</td><td></td></tr><tr><td>2018:</td><td>2137</td><td>483</td><td>2118</td></tr><tr><td></td><td></td><td>4738</td><td></td></tr></table> NOTES: The Tribal Guidelines for translocation are contained within the Tribal Pacific Lamprey Restoration Plan and were modified in 2017 to read:	2013:	BON	TDA	JDA			Total		2013:	714	304	462			1480		2014:	762	793	642			2197		2015:	867	1110	875			2852		2016:	645	784	1018			2447		2017:	1107	1588	742			3437		2018:	2137	483	2118			4738		No change anticipated. Translocation programs would likely continue to mitigate for dam passage impediments. Translocation program serves other purposes: establishing broodstock and reestablishing populations, enhancing pheromone cues, providing nutrients, benefits to overall ecosystem health.	Same as MO1.	Same as MO1 NOTES: Dam breach would have harmful short-term effects, so agencies may consider additional translocation as mitigation.	The effects would be the same as for MO1.	–
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		Collection of adult lamprey from Bonneville dam shall not exceed 50% of the total collection of adult lamprey during the active migration at any Columbia River dam (4d., page 67). Total collection of adult lamprey during the active migration at Columbia River dams by the CRITFC tribes shall not exceed 8% of the 2-year running average of the total adjusted count of upriver annual adult lamprey population based on total counts past Bonneville Dam (2% per Tribe) (4c., page 67). Based on this change, 4% shall be changed to 8% where appropriate throughout the Tribal Guidelines for Translocation (4c., 4d., and 4g.).					
Mainstem dams can cause direct mortality or physical stress among adult lamprey that use lamprey passage structures (LPS) or are otherwise diverted into collection structures or traps.	Mortality counts, rejected fish, observations of poor conditions.	Corps biologists and Corps-funded researchers periodically find dead individual lamprey in Lamprey Passage Structures (LPSs) or in holding tanks. Mortality causes are sometimes unknown (e.g. one or two individuals are found in an LPS rest box or collection tank that is operating as designed). In other instances, equipment failures (e.g. LPS pump failure due to electrical power interruption or blockages within LPSs that cause lamprey to exit the structures) lead to direct mortalities. High temperatures or other water quality issues may cause physical stress or direct mortality of individuals, particularly as lamprey are held in holding tanks for longer periods during extended periods of high temperatures. Mortality removes individuals from the system, but the number of reported mortalities is low compared to lamprey numbers.	Measure S6 is applicable. Increased passage should decrease susceptibility to physical stress and mortality. Less holding time is beneficial. Additional LPSs could slightly increase injury/stress due to LPS use, but overall benefit over fish ladder passage.	Same as MO1. DATA: S6: Lamprey Passage Structures	Columbia River: Same as MO1 Snake River: Dam breach would allow riverine passage; there is no LPS now. DATA: S7: Lamprey Passage Structures S1, S2, O1, O2: Dam Breach Snake River - See hydraulics and configuration data.	The effects would be the same as for MO1. DATA: S5 and S7.	FPOM website coordination memos (Erin Kovalchuk). Each tribe provides summary reports: Todd Sween (NP), Aaron Jackson CTUIR, Ralph Lampman (YN), Cyndi Baker or Andy Johnsen (Warm Springs). Check U of I reports or Moser

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		DATA: Observed mortalities at Corps-operated dams are reported to FPOM in the form of MFRs, which are posted to the FPOM website. There should be a decreasing trend in mortality over time as the Corps and others who collect and transport lamprey continue to identify problem areas and apply solutions. NOTES: Most issues are being addressed as they arise. The temporary/experimental nature of some structures has contributed to reliability issues with some LPSs (e.g., pump failures, lack of low water alarms, etc.). In recent years, Corps has been converting experimental structures into operational systems to improve reliability. Access to fresh, clean, cold water for collection and holding tanks can be a challenge at many locations. Tribal staff and Corps-funded researchers sometimes reject lamprey for translocation or research purposes due to poor condition, evidence of disease. Lamprey may get stressed during trapping, holding, and transport between dams and to Tribal holding facilities. CRITFC and Tribes monitor water conditions and fish conditions during holding and transport. Fish that appear lethargic or unfit are rejected from traps.					
Mainstem dams can cause direct mortality or physical stress among adult lamprey that use conventional fishways.	Mortality counts, rejected fish, observations of poor conditions.	Dead adult lamprey in various states of decomposition (i.e. single mortality events over time) are periodically found within conventional fishways. Common locations where mortalities are found include:	The effects are the same as for MO1. DATA: S9: Lamprey passage ladder modifications	No fishways on Snake River; eliminates any injury/mortality from ladders on Lower Snake River dams. DATA: S10: Lamprey Passage Modifications	The effects would be the same as for MO1. DATA: S5.	Summarized in Keefer et al., 2013; Physical stress - Mesa and Keefer et al., 2012; Mesa et al., 2003	–

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		1) BON Adult Fish Facility drain trash racks; 2) Underneath BON Bradford Island and Washington Shore fish ladder count station crowder boxes; 3) Picketed leads at various projects; 4) Underneath floor diffuser grating; 5) Upstream of picketed leads at Upstream Migrant Tunnel (UMT) junction at Cascades Island Ladder. Dead lamprey are also recovered in various fishway locations during winter maintenance dewatering events. Lamprey have been trapped under diffuser grating or in otherwise inaccessible areas, causing mortality events involving many animals. Numbers of observed mortalities are relatively minor compared to fish counts; there is a poor understanding of magnitude of the impact to populations. Improving dewatering procedures continue to adapt to reduce individual mortality. Picketed lead changed at BON Cascades Island Ladder, (prevent lamprey from getting to area where mortality occurs, have reduced impact, but not eliminated). Aside from dewatering events, causes of observed mortalities in fishways are unknown. Mesa et al. (2003) estimated the critical swimming speed (U_{crit}) and documented the physiological responses of radio-tagged and untagged adult lampreys exercised to exhaustion. Results suggested that lamprey may have difficulty negotiating conventional fishways at lower Columbia River and lower Snake River dams, where water velocities in some areas approach 2 m/s – velocities well above the mean		S1, S2, O1, O2: Dam breach.			

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		Ucrit of test fish. These are less likely to have been collected than LPS morts. There is poor understanding of the magnitude of the impact to the run. Staff only know what shows up on picket leads or observed mortality such as impingements. Measure S6 is applicable. Idea is beneficial to use an LPS instead of fishway. Expect decreasing trend in lamprey mortality as measures are implemented.					
Flow and spill interacting with project structures and temperatures can slow migration rate/passage success. High flows and lower water temperatures have been roughly correlated to poorer passage success and slower migration speed.	BON outflows/ temperatures	Much is unknown about the migration cues used by adult lamprey and how these and migration timing interact. Keefer et al. (2012) speculated that higher flows associated with higher tailwater elevations at BON may compromise attraction to fishway entrances, collection channels and transition pools of ladders. Can affect distribution of lamprey throughout the basin, but lamprey appear to have a relatively flexible migration strategy, overwintering up to two years before spawning. Impacts of different mainstem flow and temperature conditions on spawning success unclear. Within fishways, collection efficiency of LPS can be affected by discharge of LPS relative to the bulk flow within the fishway and location of the LPS. NOTES: Based on radio-telemetry and PIT tag studies, larger lamprey are more likely to pass through the hydrosystem to upstream dams. Associations are across years and interact with other factors; it is unclear why larger fish migrate farther upriver. Lowered fishway entrance velocities or flows at night improved entrance efficiency at	Attraction maintained under fish passage criteria. Likely not much change for adults migrating up. Can shift where lamprey pass, but overall passage efficiency likely not affected. Lamprey find alternative routes depending of spill and flow. DATA: MCN, JDA, TDA, BON outflows: Dec: 2%-3% higher Jun, Jul, Sep: 1% lower Apr-May: 2% lower Aug: 5-6% lower NOTES: Unknown whether spill could also affect passage efficiency; may affect what route they pass. Last year (2018), had a quick drop in spill and lamprey immediately starting passing. Not a straight relationship of more flow = less efficient passage. Tailor operations to optimize attraction. WA shore flume structure doesn't work well, but better under high flow, high tailwater.	The effects are similar to the NAA. In passage season, the 1% is within confidence intervals. DATA: MCN, JDA, TDA, BON outflows: Mar: 4% lower Apr: 2% lower May: 1% lower Jun: 1% lower Jul: Very similar to NAA Aug: 1% lower NOTES: Outflows are higher in Nov to Jan, but unknown whether this is important.	Snake River - there would be no spill issues; breach passage would be better for lamprey than ladders. Columbia River - Effects would be similar to MO2, similar to NAA but slightly lower; likely not a discernable difference in migration. DATA: MCN, JDA, TDA, BON outflows: Mar:2% lower Apr:2% lower May:3% lower Jun: 1% lower Jul: 2% lower Aug:3% lower	In wet and average years, a slight increase in flows similar to MO1 would likely not affect migration success. In dry years, the flows would be considerably higher than in the NAA in May, but in low flow years this would not likely affect migration. Higher temps in June/July could cause migration delays. DATA: Low water years: Mar, Apr: 2%-3% lower May, Jun, Jul: 2%-4% higher Normal and above years: Apr:3% lower May:2% lower Jun: 1% lower Jul: Same as NAA May to Mid-June in dry years would be about 20 kcfs higher than in the NAA.	Keefer, 2013 Johnson et al., 2011

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		BON Washington Shore Ladder (Johnson et al., 2011). Preliminary results from a 2018 study suggest a similar result at BON Bradford Island Ladder and possibly at TDA East Ladder. Lamprey passage distribution correlates with bulk flow at BON; switch from PH1 to PH2 powerhouse priority affected distribution of lamprey passage route use at BON, with more lamprey using Washington Shore Ladder in recent years. This has likely had an overall net negative effect on dam passage efficiency for lamprey, as Bradford Island Ladder consistently performs better than Washington Shore Ladder. LPSs are most effective at dead ends and narrow channels. Speculation - U of I 2014, LPS flume system at BON WA shore north downstream entrance attraction swamped by high tailwater.					
Some evidence shows adult lamprey passage efficiency may decrease with higher spill, and lower spill may increase ability of lamprey to enter fishways (Keefer et al., 2013, R. Walker, personal communication).	Spill at Columbia and Snake River dams.	NAA spill would continue to influence passage similar to recent years. The relationship is not clear but there is some evidence that continued spill increases made in may have contributed to a drop in passage efficiency that would continue, but adaptations would also continue to improve conditions for passage. NOTES: It is a challenge to pin down spill affecting passage with overall discharge and passage. Radio-telemetry and PIT studies were used to evaluate specific fishway modifications and to assess overall dam passage at BON and upstream dams. Keefer et al. (2013) reported a median fishway passage efficiency (unique lampreys that passed /	Difficult to visualize a relationship between spill and passage; increased spill periods may make it more challenging for lamprey to find fishway entrances. Similar to NAA. Block spill test design may allow opportunity to study lamprey passage. DATA: Block spill test, alternate base spill/test spill. See WQ spill presentation.	There is lower spill than in the NAA; this potentially changes routes of passage in lower river and may make it easier for adult lamprey to find entrances to fishways and LPSs. In Snake River, the relationship isn't studied; if spill affects passage, MO2 could increase passage. DATA: Spill to max 110%TDG; Less fish spill, more lack of market spill. Little Goose and Lower Granite not much change (LOM). Much lower spill at most projects in spring/summer/August. See Spill presentation for specific results. BON: 30% to 40% less spill; 50kcfs	Columbia River: Higher spill in spring/summer could cause delays. With no August spill, the tail end of migrating adults would potentially see enhanced passage compared to NAA. Snake River: Effects eliminated. DATA: No SR Dams so no spill; LC Spill to 120% TDG End summer spill July 31. See spill presentation for specific results. NOTES: Slightly higher potential for delays if there is a relationship.	Higher spill may make it more challenging for lamprey to find entrances to fishways and could reduce dam passage efficiency. Adult passage improvements would likely incorporate increased spill into planning to optimize adult passage as possible. DATA: Spill to 125% TDG BON: 220-252 kcfs	Keefer et al., 2013

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		unique lampreys that approached an entrance) from 1997 to 2010 of 0.52 at BON. Keefer et al. (2013) contrasted lamprey passage efficiency with that of adult salmonids, which averages 0.95 at BON. Dam passage efficiency at BON generally increased from the beginning of the Accords period to 2014 (Figure 29). However, passage efficiencies observed in recent years were similar from 1999 to 2002. In 2002, new spillway deflectors were installed and spill patterns changed as a result. Additionally, in 2006 spring day and night spill operations were increased to 100 Kcfs. Some of these changes may have contributed to the observed drop in passage efficiency seen between 2002 and 2007. Changes in how lamprey were tagged and handled also occurred during this time, which may have influenced lamprey passage efficiency results. It should be noted that implanting radio-transmitters in lamprey can have a tag effect that increases with tag mass in relation to fish mass (i.e., tag burden) (Keefer et al., 2012) and girth size (Lampman, 2011). The ongoing 2018 to 2019 adult lamprey passage evaluation will likely shed additional light on lamprey passage benefits resulting from lamprey passage features implemented at BON and elsewhere. There is evidence that lower spill is correlated with better entrance into fishways, but staff don't know if this affects overall dam passage; it may just change routes of passage.					

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Temperatures greater than 72°F (22.2°C) cause stress to adult lamprey and can reduce migration success.	Temperatures (throughout the basin) from the date the water reaches 72° at each project.	Temps over 72°F (22°C) cause stress and reduce migration success. Between Chief Joseph and McNary dams, the temperatures would not likely be over 22°C, but below McNary there would continue to be periods of temperatures over 22°C from a week to almost a month in most year types and up to almost two months in extreme low flow/high air temperature year types. DATA: Note: no days over 22°C in any alt. CHJ: 3d over 20°C in 2015 Ext Yr set MCN Days>22° C: AF/AT= 22, LF/HT= 56 BON Days>22°C: AF/LT=5, LF/AT=14, AF/AT = 22, LF/HT = 26 NOTES: During migration stage the initial migration goes up until temps are too high; fish may migrate faster to get out. Warm makes them active until too warm, then they lose energy and hunker down, overwinter, then continue next spring. Warm= faster is true in free flowing rivers, but interaction with dams means the stress of warm water could affect their passage efficiency.	Four fewer days exceed 22°C at McNary, but one day more at BON, minor improvement in days in high temp, low flow years in the area below McNary. May slightly improve migration in Columbia River, but likely similar to NAA. Snake River slightly cooler than NAA in July and after mid-Sept, but considerably higher than NAA in the month of August and first week or so of September (see WQ graph in presentation.) Late migrants in Snake River would likely be delayed or be temperature-stressed more than under NAA. DATA: No days over 22°C in any alt. CHJ: 2d over 20° in 2015 Ext Yr set MCN Days>22° C: AF/AT=23 , LF/HT= 52 BON Days>22°C: AF/LT=5, LF/AT=12, AF/AT = 22, LF/HT = 27 NOTES: Increased furunculosis at higher temps, likely within the confidence intervals though. Lamprey move into Snake about mid-July.	Effects would have no substantial difference from the NAA in the Columbia River. Snake River - temperatures in July and early August would be considerably warmer than in the NAA; effects would be increased thermal stress and migration delays in July. DATA: Little to no change in Lower Columbia River Note: no days over 22 in any alt. CHJ: 5d over 20° in LF/HT MCN Days>22° C: AF/AT= 22, LF/HT=58 BON Days>22°C: AF/LT=5, LF/AT= 15, AF/AT = 22, LF/HT = 27 NOTES: 1 or 2 days difference from NAA, likely not substantial difference.	Snake River: More days in July over 22°C could slow migration and cause thermal stress. Diel fluctuations would result in warmer days and cooler nights, which could be beneficial to lamprey migration; they move at night and seek refuge during day. Likely better for migration even though overall day temps are higher. Exposure may be reduced with faster migration times from dam breaches. June temps are highest. Peak migrations occur in July when starts to get cooler quicker. 10 fewer days over 22° in LF/HT years at MCN, 2 days more than NAA out of BON. DATA: Note: no days over 22 in any alt. CHJ: 3d over 20° in 2015 Ext Yr set MCN Days>22° C: AF/AT= 22, LF/HT= 46 BON Days>22°C: AF/LT=4, LF/AT=13, AF/AT = 23, LF/HT = 28 NOTES: Criteria to quit tagging is 74.	In low flow years, McNary Flow Target measure is triggered and results in more days over 22°C from McNary to Bonneville, and temps through the section from Chief Joseph to McNary had more days over 20° than NAA, although no days over 22° in any alts. At Bonneville in LF/HT years, there would be 8 more days over 22°C. These slightly warmer flows in extreme low flow/hot summer events may increase adult mortality and reduce migration success. Snake River effects would be the same as in the NAA. DATA: Minor summer increases in temperature in July in low flow years in Mid-C through MCN, but would be cooler in August. No difference in Snake River. Negligible difference in Lower Columbia No days over 22°C in any alternative. CHJ: 13d over 20° in 2015 Ext Yr set MCN Days>22° C: AF/AT= 22, LF/HT= 57 BON Days>22°C: AF/LT=5, LF/AT= 14, AF/AT = 22, LF/HT = 34 NOTES: At BON in low flow year 2015, from Jun 27-Aug 19, 36 days were over 22 C, compared to 26 days in the NAA. However, the average change in that period was an increase of 0.32°C, which is within modeling error. At CHJ, the average change from June 1 to July 30 was 1.0°C in low flow, high temp year (2015). For MO1, 2, and 3, the average increase over the NAA was 0.3°.	Keefer et al., 2013

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Predation on lamprey occurs at structures including pinnipeds at BON, sturgeon at BON, TDA, JDA and other dams. An otter was observed at BON in 2018. Dam structures and operations increase the presence or effectiveness of predators, resulting in increased predation on adult lamprey.	Observed sea lion predation on lamprey, sea lion abundance and seasonal distribution.	LPSs are covered in part to reduce predation by birds (herons, etc). Stellars are at BON almost year-round (has changed), timing more conducive to observed lamprey predation. Entrance efficiency delays into structures (fishways, LPS, etc. exposes lamprey to more predation. Nighttime velocities are reduced to enhance passage entrance and reduce predation exposure. Direct mortality due to river otter predation and indirect impacts on lamprey passage success at Corps dams is not well-documented. In September 2018, a river otter was observed on nighttime video recorded in the BON Washington Shore Ladder count slot. The presence of the otter coincided with a large downstream movement of lamprey (-336 on the night of 9/18/18) followed by an increase in the BON Washington Shore AWS Channel LPS use on 9/19/18. Bonneville project staff were unable to successfully trap and remove the animal and it is still periodically observed in the area. It is unknown whether similar incidents occur unnoticed at this and other locations. DATA: Pinniped trend and counts; Sturgeon indices. The Corps, Portland District. Fisheries Field Unit (FFU) has been monitoring pinniped predation in the BON tailrace in the spring (approximately March 1 to June 1) since 2002. In more recent years, presence of Stellar sea lions in late summer through the winter months has prompted additional monitoring from mid-August through the end of December. Sea lion abundance and	Dam passage efficiency improvements would help reduce predation risk. Lower river – little change in hydro other than spill. Spill likely doesn’t affect pinniped predation (they adapt and find prey no matter what spill).	Same as MO1 NOTES: Lower river - little change in hydro operations other than spill. See coho/ chum matrices for discussion - spill likely doesn't affect pinniped predation (they adapt and find prey no matter what spill).	Effects would be the same as MO1 DATA: Same as MO1 in lower Columbia. Snake River - no reservoirs; expect reduced piscine predators. NOTES: Lower river - little change in hydro other than spill. See coho/chum matrices for discussion - spill likely doesn't affect pinniped predation (they adapt and find prey no matter what spill).	Same as MO1 NOTES: In the lower river, there would be little change in hydrology other than spill. (See coho/chum matrices for discussion.) Spill likely doesn't affect pinniped predation (they adapt and find prey no matter what spill).	BON pinniped predation reports may be found at: http://pweb.crohms.org/tmt/documents/FPOM/2010/Task%20Groups/Task%20Group%20Pinnipeds/ Kirk et al., 2014 FPOM coordination MFRs for each operating project may be found at: http://pweb.crohms.org/tmt/documents/FPOM/2010/WA and OR sea lion reports Wolf and Jones, 1989 Bell, 1967. Merrell, 1959. Collis et al., 2015 Wagner et al., 2011.

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		predation activity peaks in May, coinciding with the early part of the adult Pacific lamprey run (which peaks in July at BON). Expanded estimates of Pacific lamprey consumption by pinnipeds at BON (during monitored months, which vary from year to year) from 2002 to 2018 ranged from 33 (2011, 0.4% of observed fish catch) to 816 (2004, 25.1% of observed catch). In 2018, estimated lamprey consumption was 58 (0.04% of total observed catch). These predation estimates are based on surface observations. Given the relatively small body size of Pacific lamprey, it is likely that additional predation occurs below the surface. The Corps considers these as minimum estimates. In 2017 and 2018, observers noted that lamprey predation events peaked during crepuscular hours. It is important to note that in some years, pulses of predation occurred in February or March, long before adult lamprey are seen passing BON count stations. It is possible that many of these lamprey are overwintered adults. WA and OR do stomach analyses of sea lions lethally removed. See their annual reports. Concentrations of sturgeon noted during fishway dewaterings, but stomach contents samples do not have lamprey evidence. Direct v indirect predation, sturgeon in fish ladders, lots of turnaround in fishways (sturgeon related?) alarm cues, pheromones, etc. Avian predation - great blue herons. Lamprey are known to respond to odorants (alarm cues, predators, pheromones, etc.); however, further research is needed to understand which					

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		odors and in what concentrations. Lamprey were found to be present in the diet of Caspian terns in southeastern Oregon and northeastern California (Collis et al., 2015).					
Juveniles							
Juveniles can be harmed by impingement in screens, mostly extended length submersible bar screens (ESBS) at MCN, LGO, and LGR.	Number impinged.	Relative route use is poorly understood, so overall impacts are not known. Fyke net evaluations of run-of-river fish at JDA, MCN, BON and other dams, the majority (>70%) of juvenile lamprey appeared to move downstream low in the water column, below the turbine intake bypass screens installed for salmonids (BioAnalysts Inc. 2000; Moursund et al., 2003; Monk et al., 2004). Bar screens cause impingement and entanglement as lamprey juveniles get tails caught in them. Direct mortality of juveniles is observed; number of fish entangled is counted. This effect description is based on observations (Moursund et al. 2002, 2003). Bar screen installations have been delayed until mid-April at McNary since 2009 to reduce effect (timing of lamprey migration). At other locations, lamprey and salmon timing conflict so bar screen installation is not delayed. Note that some dams and powerhouses have no turbine intake bypass screens (BON B1 and TDA) and that other dams have what appear to be relatively benign STSs. DATA: Results of fyke net studies provide an estimate of relative use of turbines vs. juvenile bypass systems. Direct observations of entanglement, impingement and mortalities on turbine intake bypass screens.	S8: Lamprey get impinged and potentially stuck in the 1/8-in ESBSs (extended submersible bar screens). Would convert 1/8-in ESBS to 2/29-in bar screen or 1/11-in woven screen to reduce impingement (Moursund et al., 2003b). STS screens or 3/32-in ESBSs greatly reduces impingement (Moursund et al., 2001). Laboratory studies: 3/32" ESBS 0% "stuck"; 1/8" STS ~13% stuck at 3ft/s sweeping velocities; 1/8" ESBS ~13% stuck @ 2 ft/s, ~38% stuck @ 3ft/s, and ~70% stuck @ 4 ft/s (Moursund et al., 2001). "Stuck" defined by Moursund et al. (2001) as fish that could not free itself during a 10-min rest period when flows in test chamber were reduced to zero ft/s. Moursund et al. (2003a) verified that that 2/29-in bar screen (ESBS) at John Day did minimize lamprey impingement.	The effects would be the same as for MO1.	Snake River projects - effects would be eliminated as dams are breached. Columbia River same effects as in MO1. DATA: S1, S2, O1, O2: Dam breach measures S4: Fewer Fish Screens (no installation of fish screens at McNary)	Same as MO1	Bioanalysts, Inc., 2000 Monk et al., 2004 Moursund et al., 2003 Moursund et al., 2001 Mesa et al., 2015 FPOM summarized in notes. (Peery or Eric Hockersmith)

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		NOTES: Raceways for transport facilities; criteria applied from literature, increased opening mesh size so lamprey could pass out (avoid transport). Majority probably passing below the screens. Replacement of ESBs with STSs and/or delayed installation in spring were contemplated in the 2008 Fish Accords MOA. While the operational change was made at MCN, the high estimated costs relative funding and technical feasibility issues precluded replacement. The magnitude of impact not well-understood, as relative passage distribution and magnitude across all passage routes is not known. Acoustic telemetry studies using the newly developed juvenile lamprey acoustic tag would provide the opportunity to understand relative route use, collection efficiency of bypass systems, and survival by passage route.					
Turbine cooling water strainers entrain juvenile lamprey.	Number from count and inspections.	Cooling water strainers entrain lamprey in the turbine scroll case (upstream of turbines) results in mortality. Mortality counts from routine cooling water strainer inspections at NWW dams. Mortalities are collected by CRITFC for genetic sampling. NOTES: NWW has developed a design for exclusion of juvenile lamprey and other fish from cooling water strainer intakes. The design will be tested at Ice Harbor as turbines are replaced. Design approved by FFDRWG and reviewed by the Corps' Hydroelectric Design Center (HDC) uses a vent-like cover that uses sweeping flow to prevent fish from entering the cooling	S7: Would reduce (but not likely eliminate) mortality from cooling water strainers. Expect screens to greatly reduce mortality to near zero assuming all cooling water intakes are screened. However, this assumption would need to be tested. DATA: See FPOM website for mortality counts from strainers and index counts from what CRITFC received for genotyping. NOTES: Have a design for in turbine strainers, but difficult to move forward due to magnitude of work required in turbines to install.	The effects would be the same as for MO1. DATA: S7: Turbine strainer lamprey exclusion	Same effects as in MO1. DATA: S1, S2, O1, O2: Dam breach measures S8: Turbine Strainer Lamprey Exclusion	The effects would be the same as for the NAA. DATA: There is no measure for cooling water strainers.	–

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		water intakes. 2018 Fish Accords extension MOA included commitment to seek funding to develop and implement a juvenile passage RME plan. The MOA included a commitment to develop a plan lamprey design guidelines into O&M activities. The analysis of larval mortalities from LGR Dam have provided the means to estimate effective numbers of spawners, relative reproductive success of various translocation release groups, age at outmigration, and time of migration for Pacific lamprey from the Snake River Basin. Further, the team can use sibship analysis to identify full siblings of the LGR Dam juveniles among adult collections from particular sites around the Columbia river basin and thereby identify adults with Snake River natal origins and estimate the approximate number of years these adults spent in the ocean before returning to freshwater.					
Juvenile lamprey pass via spillways causing injury, mortality, or indirect effects. Note: all passage routes can cause injury, but it is not known which route has more/less effect than others.	–	Relative route use is poorly understood, so overall impacts are not known. Cumulative effects of repeated dam passage are unknown. Results of fyke net studies provide an estimate of relative use of turbines vs. juvenile bypass systems and suggest that juvenile lamprey migrate low in the water column (perhaps reducing likelihood of spillway passage) but do not directly inform estimates of passage via spillways. Direct observation of tailrace predation by gulls is reported (Zorich et al., 2010, 2011, 2012). NOTES: Mesa et al. (2015) summarized RME associated with lamprey passage and is a good resource	S1 and S2 (additional powerhouse surface passage at Ice Harbor and McNary and ASWeirs) would change dynamics of lamprey passage (as well as salmon). More (higher percentage) lamprey would be expected to pass via surface routes vs the turbine in relation to the NAA. Don't know overall effects of this dynamic. NOTES: The distribution of juvenile lamprey is low through spillway; some pass but it's an unknown percentage. Juvenile passage - also not known if spillway is detrimental. Lamprey typically migrating in lower part of water column; spillway use - Studies at JDA and	The effects would be similar to those in MO1; the structural measures may change the dynamics of lamprey passage. A higher percentage of juvenile lamprey may pass surface routes rather than turbines with these structures, but decreased spill may lower the proportion that pass over the spillway. The overall dynamic effect to juvenile survival is not well understood. DATA: S2: Additional Powerhouse Surface Passage and S4: Upgrade to Adjustable Spillway Weirs Spill to 110%	Snake River projects - effects would be eliminated as dams are breached. Columbia River - increased spill may increase proportion over spillways, overall dynamic impact on survival not well understood. DATA: S1, S2, O1, O2: Dam breach measures Spill to 120 on Lower Columbia dams	A higher percentage of juvenile lamprey may pass surface routes rather than turbines with these structures, and increased spill may further increase the proportion over spillways rather than turbines. The overall effect on survival is not known. DATA: S1: Additional Powerhouse Surface Passage S8: Spillway Weir Notch Inserts? Spill to 125% TDG	Mesa et al., 2015 Zorich et al., 2010 Zorich et al., 2011 Zorich et al., 2012

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		for summarizing what is/is not known about potential effects of the existing structures and operations. The magnitude of impact not well-understood, as relatively passage distribution and magnitude is not known. Acoustic telemetry studies using the newly developed juvenile lamprey acoustic tag would provide the opportunity to understand relative route use, collection efficiency of bypass systems, and survival by passage route.	MCN netted screens and did capture juvenile lamprey. If they encounter screens, they are either guided up to spillways or guided into juvenile bypass facility. Some are near the surface, some are lower in water column, but don't know what the proportions are. (Moursund, 2003)				
Juvenile lamprey pass via turbines causing injury, mortality, or indirect effects.	–	Relative route use is poorly understood, so overall impacts are not known. Fyke net evaluations of run-of-river fish at JDA, MCN, BON and other dams show the majority (>70%) of juvenile lamprey appeared to move downstream low in the water column below the turbine intake bypass screens installed for salmonids (BioAnalysts Inc. 2000; Moursund et al. 2003; Monk et al. 2004). Laboratory experiments by Colotelo et al. (2012) suggest that turbine passage may be relatively benign for juvenile lamprey as compared to salmonids. Cumulative effects of repeated dam passage are unknown. Results of fyke net studies provide an estimate of relative use of turbines (~70%) vs. juvenile bypass systems (~30%). Direct observations of predation on juvenile lamprey in powerhouse tailraces suggest passage via this route is substantial. NOTES: Mesa et al. (2015) summarized RME associated with lamprey passage and is a good resource for summarizing what is/is not	S10: Improved Fish Passage Turbines See above. Proportion of lamprey passing through turbines, and those that did may experience similar or slightly better survival with improved turbines, though turbine passage is somewhat benign for lamprey. Overall net effect to juvenile survival not known. NOTES: Spill is generalized just according to the measures in each alternative; should go to actual spill data for more in-depth analysis of actual spill at each project; but the relationship is not well understood so general is about as good as it gets.	See above for context. IFP turbines may be a slight improvement or no change to lamprey survival. DATA: S1: Improved Fish Passage Turbines Spill to 110% NOTES: Spill is generalized according to the measures in each alternative; should go to actual spill data for more in-depth analysis of actual spill at each project; but the relationship is not well understood so general is about as good as it gets.	Snake River - no more turbines after dams are breached. Columbia River - turbine passage potentially reduced with higher spill, survival either similar or slightly improved with IFPs. DATA: S11: Improved Fish Passage Turbines at JDA Spill to 120 on Lower Columbia NOTES: Spill is generalized according to the measures in each alternative; should go to actual spill data for more in-depth analysis of actual spill at each project; but the relationship is not well understood so general is about as good as it gets.	Turbine passage would potentially be reduced with higher spill; survival would be either similar or slightly improved with IFPs. DATA: S4: Improved Fish Passage Turbines Spill to 125% NOTES: Spill is generalized according to the measures in each alternative; will use actual spill data for more in-depth analysis of actual spill at each project; but the relationship is not well understood so general is about as good as it gets.	–

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		known about potential effects of the existing structures and operations. The magnitude of impact not well-understood, as relatively passage distribution and magnitude is not known. Acoustic telemetry studies using the newly developed juvenile lamprey acoustic tag would provide the opportunity to understand relative route use, collection efficiency of bypass systems, and survival by passage route.					
High flow freshet events typically trigger outmigration events.	Summary hydrographs, freshet events in winter.	See MCN and TDA Flow Comparison. NOTES: Outmigration typically in high flow events, which are triggered with freshets. Mesa et al. (2015) summarized what was known about passage timing and outmigration based on Smolt Monitoring Program and other inputs. Juvenile bypass and monitoring facilities are not operated during winter months due to winter maintenance requirements and design limitations relative to cold temperatures (ice issues). This precludes direct monitoring of lamprey passing dams during winter months.	MCN and TDA Flow Forecast Comparisons Looked at summary hydrograph, discharge through the winter/ spring outmigration period appears to be similar durations and magnitudes; the timing of freshets may be slightly different. At the tail end...May/June, there is less flow in very low water years; could reduce lamprey outmigration at the tail of the migration in very low water years. MO1 shows an increased outflows in January; could increase outmigration speed of juveniles, particularly from the Umatilla and Yakima where winter rain events trigger outmigrations into the mainstem Columbia. NOTES: FPC report has outmigration timing of lamprey. Check HH data to quantify change in flow.	There is little habitat for juvenile rearing in Clearwater below Dworshak; lamprey are likely not affected by increased flows in December. December flows are within the range that occurs during fall rain events: will be more sustained and less flashy. DATA: MCN and TDA Flow Forecast Comparisons Flows show higher freshets in Dec-Jan flows, January moderately higher, lower than the NAA in March. DWR: Much higher flows in Jan-Feb in average years; wet years higher Jan but lower Feb/Mar; dry years same as the NAA in Dec-Apr, freshets in May. NOTES: Snake River effects are unknown.	Outmigration would occur in Snake in riverine environment, no reservoirs would improve swimming and reduce predation, natural freshet events would move larvae out more naturally to the Columbia River. MCN would have slightly less flow in low years could be slight decrease in outmigration. Grand Coulee would have reduced flows in spring, especially May and June (use HH data to quantify difference). Expect reduced outmigration through CHJ to MCN. DATA: MCN flows would be slightly higher flows in Dec, peaks look similar to NAA in all water years, slightly lower in Jan, similar to NAA in Feb, slightly lower in March. DWK same as NAA.	An increased hydrograph in May/June in low water years could increase outmigration triggers and speed. This could be beneficial to lamprey from upper river areas such as Upper Columbia and Upper Snake. In median water years and above, the flows are similar to the NAA. DATA: Data show higher freshets in Dec, more variability in the hydrograph, Jan-Feb flows would be higher in dry years with more peaks, and there is similar in median and slightly lower in wet years. In March, there is a peak in a freshet but maybe a modeling artifact; May-June in dry years sustains flows higher than in the NAA to meet 220kcfs flow target. DWK: Same as NAA. NOTES: JDA has lamprey counts encountered in annual reports. Use March-October. Umatilla outmigration is dependent more on rain events.	—
Hydrosystem operations affect larval lamprey rearing in shallow waters due to elevation fluctuations dewatering larvae. Fluctuation rates less than 10 cm/hour are “natural,” faster	Elevation changes at reservoirs.	Distribution of rearing habitat, and direct mortality, increased exposure to predation. MCN : 338.7 all year	BON pool elevations: Median - MO1 same as NAA - straight across 76 ft. elevation. Extreme years (1% and 99%) show some slight variation	Daily fluctuations could affect lamprey if drop ramping rates within day; stranding is not expected. DATA:	JDA drops in early June, which could strand juveniles. No Snake River reservoirs. O5a: Ramping Rates for Safety (eliminate ramping rate	Drawdowns in late March, could dewater larval lamprey rearing in sediment. Ramping rates outside of ramping rate could dewater them. Fine sediment at tributary junctions, most have lamprey,	USGS, FWS, PNNL

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rates than that can strand lamprey.		JDA: See hydrograph; 1' slow drop in Dec, 0.25' drop in Mar/early Apr TDA: 158.1' all year BON: 76' all year NOTES: The Corps funded a series of preliminary studies to evaluate potential effects of hydrosystem operations: Jolley et al. (2014, 2016) conducted surveys in mainstem areas of Columbia and lower Snake Rivers to determine presence/absence of rearing ammocoete in shallow water areas potentially vulnerable to dewatering. Lamprey ammocoetes were found at various depths in the mainstem Columbia and Snake rivers and were commonly found near tributary deltas, in areas vulnerable to changes (seasonal or otherwise) in surface elevation. Mueller et al. (2015) used existing bathymetry and operations information to model relative risk of dewatering. Liedtke et al. (2015) conducted laboratory experiments with ammocoetes, simulating dewatering events and monitoring lamprey response.	MCN: 338.7 all year. (Same as NAA) JDA: About 1' Higher than NAA Apr-Jun (see summary hydrograph), drop 1' in June TDA: Same as NAA BON: Same as NAA NOTES: Drops in pool elevation at JDA in June could strand and dewater juvenile lamprey. NOTES: Less fluctuation is better. The issue is dewatering rates, too quickly (faster than about 10cm per hour) results in stranding, and more often dewatering is more stressful for lamprey. Per H&H team - ramping rates do not change for MO1 or MO4. Daily changes, or even within a week, changes do not show up in modeling. The BON pool elevation hydrograph shows some changes in pool elevation to MO1.	O2a: Ramping Rates for Safety (eliminate ramping rate restrictions for all other purposes). MCN: 338.7 all year. (Same as NAA) JDA: Same as NAA TDA: Same as NAA BON: Same as NAA NOTES: See John Day Pool Elevations summary hydrograph for comparisons of elevations. View all elevation hydrograph data to see if any other effects would be noted that may not have been considered.	restrictions for all other purposes). MCN: Same as NAA JDA: about 0.75' higher Apr-May, drops early June TDA: Same as NAA BON: Same as NAA	Could reduce amount of habitat available for larval lamprey (Jolley et al.), difficult to quantify but anticipate an effect, probably minor to moderate. DATA: MO4 is different in drops to 72' elevation April through mid-August (drawdown to MOP). H&H indicates no change in ramping rates. Straight line across in median and 25/75 % water years, extreme years show fluctuation similar to the NAA. April drawdown on 1% down to 70' elevation lasts longer (earlier and later) than NAA. BON: Drops 3.75 ft March 25 until mid-August MCN: Drops 1.2 feet March 25 (until mid-August) JDA: Drops 2' March 25, through August is 261.75' elev. TDA: Drops 2.35 ft March 25, through Aug 14 NOTES: Lifting forebay operating restrictions may increase flexibility to operate daily fluctuations. It is unclear whether this flexibility would lead to increased drawdown rates. Ramping rates and frequency are both important.	
Temperature affects outmigration: juveniles move out of the system faster in warmer temperatures.	Temperatures through the system.	Juveniles move out of the higher systems. #Days>State temp standards: LWG: 4.4d LGS: 37d LMN: 47.2d NOTES: Juveniles move out of the system faster in warmer temps. For both experiments there was little to no tag loss, and juvenile lampreys in freshwater showed high survival at all temperatures at 7 d (95–100%) and 14 d (88–	DWA ops difference in Snake: LGR: Cooler June-Aug 1, warmer early Aug to mid Sept., Cooler mid-Sept-Oct.; increase up to 4°F with rapid fluctuation to about 3°F cooler in about a week. LGR results in several days >20°C compared to none in NAA. (from presentation, get details from WQ files). Effect continues downstream and gets attenuated. Lower Columbia similar to NAA. #Days>State temp standards:	Negligible impacts are expected based on slightly warmer temperatures in LF/HT years. Deeper winter drafts that lower outflows in spring may delay outmigration and therefore may affect juvenile lamprey by increased predation risk and increase in disease prevalence caused by warmer temps. DATA: Snake River: Check for a possible modeling error; expected to be similar to NAA. Columbia River:	Temps in early spring would be warmer than in the NAA, which would tend to increase outmigration speed, but the change to river environment likely outweighs any influence of temperature on outmigration speed. DATA: Snake River - No reservoirs; faster heating and cooling of water. Warmer early Jun-early July, cooler mid-July to Sept. #Days>State temp standards:	The effects would be no impact to negligible impact based on minor increases in summer temperatures in Columbia River. Effects in the Snake River would be the same as in the NAA. DATA: Snake River - same as NAA There would be minor summer increases in summer temperatures in July in low flow years in Mid-C through MCN. Cooler in August. There would be no difference in Snake. There	Lampman et al. Mesa et al., 2012 Meeuwig et al., 2005

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		100%) posttagging. Prolonged holding (40 d) resulted in significantly lower survival (28% to 79%) at warmer temperatures (12°C to 18°C).	LWG: 22.6 days (18.2 more than NAA) LGS: 45.6 (8.6 more than NAA) LMN: 54.4 (7.2 more than NAA) For lower Columbia River, no impact based on similarity to NAA. In Snake River, cooler in July and warmer in Aug/Sept could influence outmigration timing.	temperatures would be slightly different below GCD, slightly warmer in LF/HT year like 2015. Deeper winter draft for hydropower would mean lower outflows in spring. NOTES: Snake River, updated modeling shows temperatures would be similar to the NAA.	LWG: 16.8 days (12.4 more than NAA) LGS: 44.6 (7.6 more than NAA) LMN: 51.8 (4.6 more than NAA) See WQ/Sediment joint presentations for details. Columbia River effects would be similar to those in the NAA.	would be negligible difference in Lower Columbia River.	
Temperatures affect juvenile growth; they grow slower in cooler water, and water temperature in Clearwater River can be influenced by Dworshak releases.	Temperatures in the Clearwater River.	Cold water released from DWA for temperature control may slow juvenile lamprey growth in that area.	O15: Modified Dworshak Summer Draft Cooler June 21-Aug1, much warmer Aug to mid-Sept. Potentially slower growth of larvae in Clearwater River in June and July, but warmer in Aug to mid-Sept, but temps still within the temperature tolerance for lamprey larvae.	After the model re-run, Temperatures are similar to the NAA.	Effects would be the same as in the NAA. DATA: Similar to the NAA	The effects would be the same as in the NAA. DATA: Similar to NAA	–
Contaminants (mainstem). Juvenile lamprey are sensitive to contaminant.	Sediment mobilization	All life stages of Pacific lamprey can be affected by contaminants (CRITFC, 2011). Contaminants, such as methylmercury, are bioaccumulated in larval lamprey and can have ecosystem effects on predators that prey on them (Bettaso and Goodman, 2008). Nilsen et al (2007) found 13 known endocrine disrupting compounds in the lower Columbia basin. Geeraerts and Belpaire (2010) found, in European eels, contaminants can disturb the immune system, reproductive system, nervous system and endocrine system at the subcellular, organ, individual, and population levels. However, direct effects have not been studied in lampreys. Studies looking at salmonids have shown direct effects of contaminants, such as increases in susceptibility to disease (Arkoosh et al. 2010) and negative effects on growth and reproduction (Depew et al. 2012). Lamprey overlap or have similar habitats and lipid content	NOTES: Look at Outflow comparison to see if any expected differences to sediment mobilization. Potential change in mercury methylation events?	NOTE: Look at outflow comparison to see if there are any expected differences to sediment mobilization. Unknown whether there is a potential change in mercury methylation events.	Long-term effects would be similar to the NAA. DATA: See WQ/Sediment joint presentations for details. Analyze long-term effects in this row. Short-term impacts of actual breach are in separate a row below.	NOTE: Look at Outflow comparison to see if any expected differences to sediment mobilization. Look for potential change in mercury methylation events.	Elena Nilsen et al., 2007 and 2015

Affected Environment Important Relationships / Criteria	Affected Environment Metric	Environmental Consequences NAA	Environmental Consequences MO1	Environmental Consequences MO2	Environmental Consequences MO3	Environmental Consequences MO4	Notes
		as salmonids and therefore effects of contaminants on salmonids may provide information on contaminant effects on lampreys (Nilsen et al. 2015).					
Juvenile predation: Juvenile lamprey can become disoriented at powerhouses and become more susceptible to predation by gulls.	–	Relative route use is poorly understood, so overall impacts are not known. Fyke net evaluations of run-of-river fish at JDA, MCN, BON and other dams, the majority (>70%) of juvenile lamprey appeared to move downstream low in the water column, below the turbine intake bypass screens installed for salmonids (BioAnalysts Inc., 2000; Moursund et al. ,2003; Monk et al.,2004). Predation in powerhouse tailraces observed by Zorich et al. (2010, 2011, 2012) and anecdotal observations by pikeminnow anglers (Mesa et al., 2015) suggests that many lamprey likely pass via turbines and that they are at least temporarily vulnerable to predation immediately following turbine passage. Avian predation deterrence in the form of Corps-funded hazing and presence of avian wire arrays and other passive features will continue. NOTES: Mesa et al. (2015) summarized RME associated with lamprey passage and is a good resource for summarizing what is/is not known about potential effects of the existing structures and operations. Observations of gulls switching from salmon at spillways to lamprey at powerhouses at JDA and TDA. Studies document walleye/small mouth bass predation on lamprey, and avian predation.	MCN and TDA: Flows are very similar to NAA except slight decreases under MO1. Are these slight decreases in flow biologically relevant? Understanding the effects of these flow relationships, routes of passage and route survival are not well understood. Therefore, impacts are unknown but likely negligible. DATA: See flow and spill relationships.	Same response as MO1. DATA: See flow and spill relationships. NOTES: Powerhouse encounters for lamprey are uncertain.	Effects would be beneficial to juvenile lamprey in the Snake River. Lower Columbia River effects would be similar to those in the NAA. DATA: Dam breach - fewer powerhouse encounters.	MCN has large spikes in flow at the end of March and a large drop in flows mid-August. TDA has similar spikes that are smaller in magnitude. It is difficult to determine how these impact juveniles for the same reasons explained in NAA. However, increased flows will likely result in fast outmigration resulting in a benefit and less flow in slower migration increasing predation risk. There are likely overall minor impacts under low flow conditions in mid-August and a benefit in high flows at the end of March. Lamprey juveniles are present during both the low spike and high spike. DATA: See flow and spill relationships.	Summarized in Mesa, 2015 Zorich et al.

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Affected Environment Important Relationships / Criteria	Affected Environment Metric	Environmental Consequences NAA	Environmental Consequences MO1	Environmental Consequences MO2	Environmental Consequences MO3	Environmental Consequences MO4	Notes
Dredging as part of ongoing project O&M can harm juvenile lamprey.	Juveniles detected in dredging area	The Corps periodically dredges at BON forebay locations, including immediately upstream of Bradford Island Fish Ladder exit and upstream of Washington shore fish turbine units. Dredging is necessary to remove debris and ensure that fish passage facilities are operating as designed. O&M dredging at BON is expected to continue as needed. NOTES: USFWS biologists used deepwater electrofishing/suction dredge equipment to sample for lamprey ammocoetes in proximity of the BON Bradford Island Fish Ladder exit in January 2016 in advance of dredging activity in this area. According to a memo documenting findings, six of 17 10x10 m quadrats contained lamprey ammocoetes, representing a detection rate of 0.35 (the highest detection rate observed by the USFWS team). An abundance estimate for the area was approximately 3,500 individuals. Impacts on lamprey present are unknown but larval lamprey are present and abundant in the area.	Similar to NAA based on reduced flows under MO1 reducing sediment transport resulting in the same or less dredging.	Increase in flows likely result in increases in dredging and therefore minor impacts to larval lamprey.	Potentially more dredging upstream of MCN.	Higher flows in some water years and months could result in increased dredging frequency and therefore minor impacts to larval lamprey. (Minor because the dredged areas in the BON forebay did have larval lamprey, but the overall population effect is likely minor).	Jeff Jolley, USFWS memorandum “Bonneville Forebay Larval Lamprey Sampling 2016” (dated 1/27/16).
Federal navigation channel maintenance dredging in the lower Snake River and below BON.	–	Navigation channel maintenance will continue to occur periodically. Although juvenile lamprey may be present in areas targeted for dredging, densities are thought to be site-specific and most likely seasonal. Direct effects of the dredging action on juvenile lamprey are not well understood. NOTES: Pre- and post-dredge monitoring may be important to understand effects.	Same as NAA. DATA: No change to dredging NOTES: Sediment team concluded no increase in dredging anticipated under any of the alternatives.	The same effects would be expected as for the NAA. DATA: No change to dredging. NOTE: See MO3 note.	The effects would be the same as for the NAA. DATA: No change to dredging. NOTES: Sediment team concluded no increase in dredging anticipated under any of the alternatives.	The effects would be the same as for the NAA. DATA: No change to dredging. NOTES: See MO3 Note.	–

3.7.3.1 MO3: Dam Breach Measure

Dam breach could result in perched tributaries: Tucannon and Palouse could have short-term passage issues. Could implement a translocation program moving lamprey into tributaries.

Dissolved Oxygen - lamprey overwintering in headwaters area of LMN could see effects going into winter mode. Peak 1 in mid-Sept would likely impact adults, in Oct may survive due to low oxygen demand as going to overwinter mode. This would impact the end of the run in Sept. of active migrants. Shifting later could lower lamprey effects, but construction timing is likely tailored to salmonids. There would be local effects to LMN fish (check passage counts, assume some overwintering, check Nez Perce for translocation info), but the amount is uncertain; some migration would be coming through.

Juveniles - larval survive very low DO, (0.1mg/l) (Barren and Gannan research). Reservoirs being dewatered would result in exposing tributary mouth sediments, 2ft/day dewatering rate, larval lamprey would likely move out with the dewatering.

Suspended sediments could impact ability of adults to cue in on pheromones from larvae.

Dam breach activities are likely to mobilize contaminants in sediments from reservoirs in Snake River for 5 to 7 years until system reaches equilibrium.

DATA:

Short-term data for analysis: 2 construction seasons; sediment movement; anoxia would occur into river and unbreached reservoirs - DO expected to endure for an estimated 10-15 days < 2.5mg/L in Aug and Oct.; suspended sediment would be high concentrations; contaminants may mobilize and cause bioaccumulation. See sediment movement presentation for data.

Tributary deposition would occur in backwater areas, and there would be a temporarily denuded floodplain. Bed material quality would have deposited fines over bed material. The estimate is that it would take over 100kcfs to clear, but would likely take a flood event. Long-term data for analysis: See velocities and depths from the Dam breach presentation from the Hydraulic Engineer team.

PACIFIC LAMPREY RESOURCES

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3.7.4 American Shad

Table 3-67. Columbia River Shad Salmon Qualitative Effects Analysis Matrix

Affected Environment Important Relationships/Criteria	Affected Environment Metric	Environmental Consequences NAA	Environmental Consequences MO1	Environmental Consequences MO2	Environmental Consequences MO3	Environmental Consequences MO4	Notes
Juvenile Mainstem Passage							
Presence of reservoirs positively affects shad spawning and rearing habitat area. Shad spawn in shallow water with depth of 3 feet to 30 feet over sand and gravel. There is rearing in the main channel and off-channel areas with dense aquatic vegetation.	Change in reservoir shoreline area.	H&H and Water Quality Outputs: Reservoir shoreline analysis (Section 3.6). Effects to Resource – NAA Shad have been steadily increasing in abundance in the Columbia and Snake Rivers. In the last 20 years, 3% to 13% of shad counted at BON have also passed IHR and entered the Snake River. Several thousand have reached LGR reservoir in recent years. Shad do not migrate as far during years with high flow/spill. Shad are also abundant below Bonneville Dam where iteroparity is observed. Off channel rearing habitat most available in McNary reservoir and estuary.	Minor changes in depth and flows are unlikely to affect ability of shad to spawn. There will be an increased forebay range at JDA, 1 foot higher in Apr to Jun.	Minor changes are unlikely to affect spawning and rearing (up to 0.5-foot difference in surface elevations). Conditions similar to NAA.	Lower Columbia will have minor changes (JDA 1 foot higher in April-June). Snake River will no longer have reservoir environment. Average decrease in width of 500 feet. Expect high mortality during dam breach. Long term expectation of much lower rearing capacity, and lower migration into Snake River. Sediment from Snake could create additional wetland area in MCN pool.	At each project, drop in elevation could potentially change reservoir conditions, but the reservoirs are so big it likely would not change conditions for shad. Drawdown to MOP BON: Drops 3.75 feet Mar 25 until mid-Aug MCN: Drops 1.2 feet Mar 25 (until mid-Aug) JDA: Drops 2 feet Mar 25, through Aug. Elevation 261.75 feet TDA: Drops 2.35 feet Mar 25, through Aug 14.	Petersen et al. 2003, Gadomski and Barfoot 1998, Hinrichsen et al 2013, Hasselman et al. 2012a, b; Quinn and Adams 1996.
Rearing juvenile shad consume a large percentage of zooplankton production, especially Daphnia spp., and compete with rearing subyearling Chinook salmon in early summer.	Change in reservoir zooplankton.	H&H and Water Quality Outputs: Zooplankton qualitative assessment from water quality analysis. Effects to Resource – NAA Years with higher temperatures increase zooplankton primary production. Higher summer flows decrease reservoir retention time of zooplankton. Adults do not feed during migration. After spawning, shad provide large inputs of marine derived nutrients and may thus increase zooplankton productivity.	LGR pool: downstream to MCN dam- Possible species composition shift, but could also have more growth in summer. MCN to BON - no change expected. Shad are generalists. A shift in zooplankton community composition is unlikely to result in strong effect. LGR to MCN- no change expected. MCN to BON - no change expected.	Lower Granite to MCN: Very different food web dynamics - riverine instead of reservoir. Secondary productivity will eventually shift to benthic macroinvertebrates. Would expect fewer shad in Snake River. Zooplankton less than 1/10th of NAA. MCN to BON Short term: heavy sediment loads reduce zooplankton development for 2 to 7 years. New equilibrium of zooplankton density and species composition may be fairly similar.	LGR to MCN - No expected change. MCN downstream - Little or no expected change.	–	Haskell et al., 2013, Haskell et al., 2017, Haskell et al., 2018, Haskell et al., 2006, Hammann, 1981

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Affected Environment Important Relationships/Criteria	Affected Environment Metric	Environmental Consequences NAA	Environmental Consequences MO1	Environmental Consequences MO2	Environmental Consequences MO3	Environmental Consequences MO4	Notes
Juvenile shad present in the river basin predated on by fall Chinook salmon, bass, catfish, pikeminnow and walleye.	Change in predatory fish.	H&H and Water Quality Outputs: Resident fish analysis Effects to Resource – NAA Complex food web relationships. The presence of juvenile shad increases growth of fish predators, including pikeminnow, bass, catfish and walleye and contributes to the overwinter survival and it could increase predation on salmonids. Yet, juvenile shad are a major food source for fall Chinook in late summer. Chinook also predate on shad eggs. Shad tend to swamp avian predators at East Sand Island during salmon outmigration.	LGR to MCN - no change expected. MCN to BON - no change expected.	LGR to MCN - no change expected. MCN to BON - no change expected.	LGR to MCN – reduction in warm water predators (bass, walleye, pikeminnow) due to reduction of habitat. Fall Chinook may increase. MCN to BON - no change expected.	LGR to MCN - no change expected. MCN to BON - no change expected.	Harvey and Kareiva, 2005 Sanderson et al., 2009 Hinrichsen et al., 2013,

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3.8 RESIDENT FISH

3.8.1 Region A

3.8.1.1 Kootenai Basin

Table 3-68. Columbia River Kootenai Regional Qualitative Effects Analysis Matrix

Affected Environment Important Relationships/Criteria	Affected Environment Metric	Environmental Consequences NAA	Environmental Consequences MO1	Environmental Consequences MO2	Environmental Consequences MO3	Environmental Consequences MO4	Notes
Ecosystem Metabolism							
Reservoir Discharge Effects							
Higher and prolonged early spring Libby Dam flow for riverine ecosystem function mid-March through mid-May	Departure from pre-dam (1943-1972) rate of LIBBY DAM FLOW increase (425.7 cfs/day) 15 March - 15 May	Rate of LIBBY DAM FLOW increase of 157 (50 - 295) cfs/day between mid-March and mid-May NAA rate of spring freshet flow increase provides ~ 1/3 of the pre-dam mean rate of flow increase.	99 (-2 - 238) cfs/day MO1 rates of spring freshet flow increase are lower than the NAA (Decreases in river productivity).	93 (18 - 223) cfs/day MO2 rates of spring freshet flow increase are lower than the NAA (Decreases in river productivity).	93 (18 - 224) cfs/day MO3 rates of spring freshet flow increase are lower than the NAA (Decreases in river productivity).	104 (-2 - 249) cfs/day MO4 rates of spring freshet flow increase are lower than the NAA (Decreases in river productivity).	During this period, it is critical for river flow and stage to rise and inundate riparian and side channel habitat to commence and sustain ecosystem productivity. Delay in commencement of river productivity is detrimental to ALL species and ALL life stages, and prevents establishment of self-sustaining populations of endangered, threatened, and sensitive fish species due to impacts to physiological development. VARQ operations at Libby Dam (ALL Alternatives) delays normative (pre-dam) discharge increases by ~ 6 weeks
Temperature Effects							
Temperature for life history physiology: Mid-March = 6°C Mid-April = 8°C Mid-May = 10°C	Mean monthly reservoir temperatures for: Mid-March Mid-April, and Mid-May	NAA Mean Monthly Bonners Ferry Temperatures: MAR: 3.83°C APR: 5.65°C MAY: 8.29°C NAA (and current) spring temperatures are much too cold for ALL species' developmental physiology.	MO1 Median 3.83°C 5.65°C 8.32°C MO1 Spring temperatures are not different from the NAA.	MO2 Median 3.83°C 5.65°C 8.32°C MO1 Spring temperatures are not different from the NAA.	MO3 Median 3.83°C 5.65°C 8.35°C MO1 Spring temperatures are not different from the NAA.	MO4 Median 3.83°C 5.65°C 8.35°C MO1 Spring temperatures are not different from the NAA.	Mean monthly reservoir temperature influences mean monthly Bonners Ferry Temperature. MO3 is potentially beneficial in that it drafts the reservoir deeper through the winter (median) than NAA, and thus may enhance reservoir warming during spring and early summer, though All MO's achieve similar maximum drawdown in April. Best temperature management capability for spring and early summer is present when the reservoir is drafted deep during winter and early spring.

Affected Environment Important Relationships/Criteria	Affected Environment Metric	Environmental Consequences NAA	Environmental Consequences MO1	Environmental Consequences MO2	Environmental Consequences MO3	Environmental Consequences MO4	Notes
Riparian Function							
Reservoir Discharge Effects							
Libby Dam flow fluctuations during the winter impact benthic ecology.	Daily flow shape	No data available to assess within day variability. No analysis conducted for this metric.	–	–	–	–	All Alternative winter operations (relaxed ramping rates) allow for varial zone desiccation, re-inundation, and freezing. May impact species bioenergetics - increased metabolic activity. Winter load shaping/following is deleterious to benthic ecology.
River Stage Effects							
Bonnars Ferry elevation difference between spring freshet and winter peak are important for riparian community establishment and survival. The larger the number, the greater chance for revegetation.	Number of days when winter peak stage does not exceed seeding peak (15 June to 15 July) stage	NAA: 15 Days (2-30) On average, about half the time flows would exceed the seeding peak under the NAA.	18 (6-30) There would be a minor decrease in the number of days seeding peak would be exceeded.	16 (4 - 30) Only one day difference from NAA. No change from the NAA.	16 (4 - 30) Only one day difference from NAA. No change from the NAA.	19 (6-30) There would be a minor decrease in the number of days seeding peak would be exceeded.	Annually, cottonwood and willow seeds establish within the spring peak zone below existing vegetation and survive throughout the growing season. However, they are no longer present in the early spring, likely due to the impacts of winter operations (peak flows, ramping, shear stress, etc.). During high water years (e.g., 2006, 2011, 2012), seedlings have successfully established and survived well above winter flow impact areas. Seedling survival is decreased due to the duration of exposure to winter inundation, load shaping, shear stress and erosion.
Difference in Bonners Ferry stage between seeding period (15 June to 15 July) and winter peak stage. The greater the difference, the greater the area of potential revegetation.	Difference in river stage between the seeding (15 June to 15 July) and winter peak stage	NAA: 1.0 NAA provides a one foot band of potential revegetation.	1.2 Stage difference increases by 2.4 inches under MO1 - negligible increase in potential revegetation.	-0.3 Stage difference decreases by 130% under MO2 - Minor increase in potential revegetation.	-0.3 Stage difference decreases by 130% under MO3 - Minor increase in potential revegetation.	1.8 Stage difference increases by 80%, or ~ 10 inches, under MO4 - moderate increase in potential revegetation.	The larger the difference between peak seeding and peak winter flows, the more area is available for riparian establishment. Relationship between area and river stage is dependent on geomorphology (i.e., Canyon vs Meander reaches).

Affected Environment Important Relationships/Criteria	Affected Environment Metric	Environmental Consequences NAA	Environmental Consequences MO1	Environmental Consequences MO2	Environmental Consequences MO3	Environmental Consequences MO4	Notes
Rate of Bonners Ferry flow recession is related to cottonwood recruitment.	Recession rate of less than 1" (2.5 cm)/day during seeding season (15 June to 15 July)	NAA Recession Rate = 4.3 cm/day. Exceeds optimal recession rate by 1.8 cm/day - Cottonwood recruitment may be limited under the NAA.	Recession Rate = 4.2 cm/day. Exceeds optimal recession rate by 1.7 cm/day - Cottonwood recruitment may be limited under the NAA.	Recession Rate = 4.2 cm/day. Exceeds optimal recession rate by 1.7 cm/day - Cottonwood recruitment may be limited under theNAA	Recession Rate = 4.2 cm/day. Exceeds optimal recession rate by 1.7 cm/day - Cottonwood recruitment may be limited under the NAA.	Recession Rate = 3.6 cm/dayExceeds optimal recession rate by 1.1 cm/day - Cottonwood recruitment may be limited under the NAA.	Cottonwood roots must stay in contact with moist soil and grow approximately 1" (2.5 cm)/day. In fine soils and with spring moisture, soils likely stay moist in the root zone, even when recession rates decline faster than root growth can occur. Maintaining recession rates (less than 2.5"/day) would better promote cottonwood establishment, but a steeper decline may be offset by other factors such as soil type and precipitation. All MOs have average recession rates that are faster than what is considered optimal, but due to spring precipitation and soil wicking, seedlings may be able to maintain contact with moist soil to prevent desiccation. MO4 has a slower rate which could be more beneficial to cottonwood survival. It would be more beneficial to continue the declining limb consistently to the base flow period, as with the other MOs, than dropping the stage substantially in August, as depicted under MO4.

Affected Environment Important Relationships/Criteria	Affected Environment Metric	Environmental Consequences NAA	Environmental Consequences MO1	Environmental Consequences MO2	Environmental Consequences MO3	Environmental Consequences MO4	Notes
Kootenai River White Sturgeon							
Reservoir Discharge Effects							
Higher and prolonged peak Bonners Ferry flow for spawning mid-May through mid-July. Longer the peak, the more likely sturgeon are to be attracted to suitable spawning habitats.	Number of consecutive days of high/prolonged BONNERS FERRY FLOW of 30+ kcfs at Bonners Ferry (magnitude and duration) desired for sturgeon spawning	NAA provides 19 (14 - 25) days of PEAK BONNERS FERRY FLOW of 30+ kcfs between 15 May and 15 July	18 (11 - 25) days MO1 would have 1 day less than the NAA of peak flows - Negligible effect on sturgeon attraction compared to the NAA.	18 (10 - 25) days MO2 would have 1 day less than the NAA of peak flows - Negligible effect on sturgeon attraction compared to the NAA.	18 (10 - 25) days MO3 would have 1 day less than the NAA of peak flows - Negligible effect on sturgeon attraction compared to the NAA.	19 (12 - 26) days MO4 would not differ from the NAA.	Sturgeon spawning habitat is more suitable upstream of Bonners Ferry. Reducing the number of days where flow >30k cfs will reduce the proportion of spawning sturgeon that migrate to this habitat. Increasing the likelihood of fish migrating to these habitats may increase the probability of successful spawning, egg incubation, and juvenile rearing (natural recruitment is a condition of species recovery). Effects are unknown - this metric was unable to detect differences in the alternatives.
Bonners Ferry flow freshet shape – ramping rates pre-spawn, spawn, and post-spawn. Shape of receding limb to summer flow is important for egg deposition.	Mean BONNERS FERRY FLOW (kcfs) and BONNERS FERRY ELEVATION (MSL) reduction between PEAK BONNERS FERRY FLOW and 15 July	NAA provides a FRESHET SHAPE of 50-54 days between BONNERS FERRY FLOW PEAK (23 - 27 May) and 15 July @ 406.7 - 499.3 cfs/day	50 - 54 days / 23 - 27 May / 357.0 - 499.5 cfs/day MO1 would not differ from the NAA	42 - 54 days / 23 May - 04 June / 384.7 - 510.4 cfs/day MO2 could have a shorter freshet that may occur later in the season when compared to the NAA	42 - 54 days / 23 May - 04 June / 384.7 - 510.4 cfs/day MO3 could have a shorter freshet that may occur later in the season when compared to the NAA	51 - 53 days / 24 - 26 May / 329.7 - 448.7 cfs/day MO4 could have a longer freshet compared to the NAA	BONNERS FERRY FLOW PEAK is related to sturgeon spawning behavior; relationship to wild recruitment is unknown. This metric does not detect differences in the alternatives. Rate of recession of the hydrograph appears to provide cues to trigger egg deposition (with understanding that there is variation for shaping of the hydrograph adaptively in-season via BiOp FPIP process). Decreased rates of flow recession increase the duration of egg deposition. It remains unclear whether increased period duration of egg deposition is beneficial or deleterious to sturgeon egg incubation and recruitment.
Higher and prolonged early spring Libby Dam flow for riverine ecosystem function mid-March through mid-May.	Departure from pre-dam (1943-1972) rate of LIBBY DAM FLOW increase (425.7 cfs/day) 15 March - 15 May	Rate of LIBBY DAM FLOW increase of 157 (50 - 295) cfs/day between mid-March and mid-MayNAA rate of spring freshet flow increase provides ~ 1/3 of the pre-dam mean rate of flow increase.	99 (-2 - 238) C10cfs/dayMO1 rates of spring freshet flow increase are lower than the NAA (Decreases in river productivity).	93 (18 - 223) cfs/dayMO2 rates of spring freshet flow increase are lower than the NAA (Decreases in river productivity).	93 (18 - 224) cfs/dayMO3 rates of spring freshet flow increase are lower than the NAA (Decreases in river productivity).	104 (-2 - 249) cfs/dayMO4 rates of spring freshet flow increase are lower than the NAA (Decreases in river productivity).	–

Affected Environment Important Relationships/Criteria	Affected Environment Metric	Environmental Consequences NAA	Environmental Consequences MO1	Environmental Consequences MO2	Environmental Consequences MO3	Environmental Consequences MO4	Notes
River Stage Effects							
Difference in Bonners Ferry stage between the seeding period (15 June to 15 July) and winter peak stage. The greater the difference, the greater the area of potential revegetation.	Difference in river stage between the seeding (15 June to 15 July) and winter peak stage	NAA: 1.0 NAA provides a one foot band of potential revegetation.	1.2 Stage difference increases by 2.4 inches under MO1 - negligible increase in potential revegetation.	-0.3 Stage difference decreases by 130% under MO2 - Minor increase in potential revegetation.	-0.3 Stage difference decreases by 130% under MO3 - Minor increase in potential revegetation.	1.8 Stage difference increases by 80% or ~ 10 inches under MO4 - moderate increase in potential revegetation.	Effects to Sturgeon are unknown. Unconnected floodplains have the potential to strand juvenile sturgeon. Juvenile sturgeon have become stranded over winter in off channel habitat following high water events. Intent is to maximize aerial extent of spring-inundated areas that are not re-inundated the following winter.
Bonners Ferry flow peak and duration of high flows provides backwater and slough habitat important for larval and juvenile rearing. Floodplain connection linked to high runoff and wet years.	Number of days above BONNERS FERRY ELEVATION 1758' (surrogate for duration) at Nimz Ranch reference site	NAA provides 7 days above 1758' during larval emergence and development stage NAA Median provides sufficient floodplain connectivity at Nimz Ranch reference site.	16 days MO1 would have one day less of flows above 1758 = Negligible decrease compared to the NAA.	16 days MO2 would have one day less of flows above 1758 = Negligible decrease compared to the NAA.	16 days MO3 would have one day less of flows above 1758 = Negligible decrease compared to the NAA.	17 days MO4 would not differ from the NAA.	Currently unknown if juvenile sturgeon occupy this habitat. Believe any increase in access to juvenile rearing habitat (e.g. floodplain habitat) would be beneficial. However, over winter stranding is a concern with an increase in connectivity. Connectivity of floodplain habitats may increase food production for larval and juvenile sturgeon, but this is currently unknown. Relation is confounded by other temperature and productivity relations. If too cold no production in backwater habitat. Desire is to maximize aerial extent and duration of spring-inundated areas correlated with Klockmann gage to determine connection. Ecosystem functions include food and hiding habitat, warmer water for better growth and productivity.

Affected Environment Important Relationships/Criteria	Affected Environment Metric	Environmental Consequences NAA	Environmental Consequences MO1	Environmental Consequences MO2	Environmental Consequences MO3	Environmental Consequences MO4	Notes
Temperature Effects							
Mean monthly reservoir temperature profile (winter/spring) – discharge temperature is influenced by Libby elevation. Later winter/early spring (March to early May), higher pool elevations result in cooler discharge. Warmer water (10°C) is needed for spawning (late May to early July).	MEAN MONTHLY RESERVOIR TEMPERATURE influences discharge LIBBY DAM DISCHARGE TEMPERATURE	NAA Median MEAN MONTHLY RESERVOIR TEMPERATURE: MAR: 3.51°C APR: 3.79°C MAY: 6.22°C JUN: 9.17°C JUL: 10.78°C No difference from the NAA	MO1 Median 3.51°C 3.79°C 6.25°C 8.94°C 10.72°C No difference from the NAA	MO2 Median 3.51°C 3.79°C 6.28°C 9.00°C 10.44°C No difference from the NAA	MO3 Median 3.51°C 3.79°C 6.28°C 9.00°C 10.44°C No difference from the NAA	MO4 Median 3.51°C 3.79°C 6.25°C 8.89°C 10.50°C No difference from the NAA	Egg deposition generally occurs at temperatures >8°C with a peak at approximately 9.5°C to 9.9°C. Duration of egg incubation is inversely related to temperature (e.g., higher temperatures reduce incubation time). The effects of the MOs on temperature are not significantly different than the NAA. Higher pool elevation through the winter associated with VARQ can result in a colder thermal mass that warms slower than optimal - lower pool elevation can result in quicker springtime warming of the forebay, and thus warmer discharge temperature during spring and early summer.
Bonniers Ferry temperature of 8.5°C to 12°C during mid-May through mid-July to initiate and support sturgeon spawning.	MEAN MONTHLY BONNERS FERRY TEMPERATURE between May and June of 8.5°C to 12 °C	NAA Median: MAY: 8.29°C JUN: 11.08°C JUL: 13.54°C (based on MEAN MONTHLY RESERVOIR ELEVATION and EMPIRICAL DATA).	MO1 Median 8.32°C 10.85°C 13.49°C No difference from the NAA	MO2 Median 8.35°C 10.91°C 13.21°C No difference from the NAA	MO3 Median 8.35°C 10.91°C 13.21°C No difference from the NAA	MO4 Median 8.32°C 10.80°C 13.26°C No difference from the NAA	Egg deposition generally occurs at temperatures >8°C with a peak at approximately 9.5°C to 9.9°C. Duration of egg incubation is inversely related to temperature (e.g., higher temperatures reduce incubation time).
Bonniers Ferry temperature progression to allow for progression of species physiology: Mid-March: 6°C Mid-April: 8°C Mid-May: 10°C Mid-June: 12°C End-June: 14°C	MEAN MONTHLY RESERVOIR TEMPERATURE influences MEAN MONTHLY BONNERS FERRY TEMPERATURE	NAA Medians FEB: 2.83°C MAR: 3.83°C APR: 5.65°C MAY: 8.29°C JUN: 11.08°C JUL: 13.54°C NAA Does not provide appropriate mean monthly temperatures at Bonners Ferry for physiological progression of Sturgeon. Spring temperatures increase too slowly because of reservoir water mass and is too cold to allow for proper body development, growth, and survival.	MO1 Medians 2.83°C 3.83°C 5.65°C 8.32°C 10.85°C 13.56°C Does not differ from the NAA.	MO2 Medians 2.83°C 3.83°C 5.65°C 8.32°C 10.80°C 13.26°C Does not differ from the NAA.	MO3 Medians 2.83°C 3.83°C 5.65°C 8.35°C 10.91°C 13.21°C Does not differ from the NAA.	MO4 Medians 2.83°C 3.83°C 5.65°C 8.35°C 10.91°C 13.21°C Does not differ from the NAA.	Pre-dam temperatures in the Kootenai River were consistently cold in the winter months (i.e., November-March) and the sharply rose in the spring (i.e., April, May, and June). This thermograph provided suitable temperature for sturgeon spawning, egg incubation, larval development and feeding in the spring and summer. All MOs offer only marginal differences from the NAA, so it is likely there would be no benefit or detriment to sturgeon due to Libby Dam's temperature management capabilities. However, alternatives that reduce winter volume in Lake Koocanusa may be more allow for warmer water during the critical spring period.

Affected Environment Important Relationships/Criteria	Affected Environment Metric	Environmental Consequences NAA	Environmental Consequences MO1	Environmental Consequences MO2	Environmental Consequences MO3	Environmental Consequences MO4	Notes
Burbot							
Reservoir Elevation Effects							
Entrainment of eggs and larval burbot through Libby Dam during March through early April.	MEAN LIBBY DAM FLOW between 01 March and 15 April	Mean Libby Out Flow: 4.0 - 11.0 kcfs Lower discharge entrains fewer eggs and larvae. Some unknown number of eggs and larvae would be entrained.	4.0 - 14.1 kcfs Negligible effects. No change from NAA.	4.0 - 12.6 kcfs Negligible effects. No change from NAA.	4.0 - 12.6 kcfs Negligible effects. No change from NAA.	4.0 - 13.4 kcfs Negligible effects. No change from NAA.	Although not explicitly quantified, lower discharge entrains fewer eggs and larvae.
Reservoir Discharge Effects							
Higher and prolonged early spring Libby Dam flow for riverine ecosystem function mid-March through mid-May.	Departure from pre-dam (1943-1972) rate of Libby Dam flow increase (425.7 cfs/day) 15 March to 15 May	Rate of Libby Dam flow increase of 157 (50 - 295) cfs/day between mid-March and mid-May NAA rate of spring freshet flow increase provides ~ 1/3 of the pre-dam mean rate of flow increase.	99 (-2 - 238) cfs/day MO1 rates of spring freshet flow increase are lower than the NAA (Decreases in river productivity).	93 (18 - 223) cfs/day MO2 rates of spring freshet flow increase are lower than the NAA (Decreases in river productivity).	93 (18 - 224) cfs/day MO3 rates of spring freshet flow increase are lower than the NAA (Decreases in river productivity).	104 (-2 - 249) cfs/day MO4 rates of spring freshet flow increase are lower than the NAA (Decreases in river productivity).	During this period, it is critical for river flow and stage to rise and inundate riparian and side channel habitat to commence and sustain ecosystem productivity. Delay in commencement of river productivity is detrimental to ALL species and ALL life stages, and prevents establishment of self-sustaining populations of endangered, threatened, and sensitive fish species due to impacts to physiological development. VARQ operations at Libby Dam (ALL Alternatives) delays normative (pre-dam) discharge increases by ~ 6 weeks

Affected Environment Important Relationships/Criteria	Affected Environment Metric	Environmental Consequences NAA	Environmental Consequences MO1	Environmental Consequences MO2	Environmental Consequences MO3	Environmental Consequences MO4	Notes
River Stage Effects							
Altered seasonal flow regime/floodplain connectivity.	Number of days above BONNERS FERRY ELEVATION 1758' (surrogate for duration) at Nimz Ranch reference site	NAA provides 17 days above 1758' during larval emergence and development stageNAA Median provides sufficient floodplain connectivity at Nimz Ranch reference site for burbot; however, it is likely that larval and juvenile burbot would benefit from an even longer duration of inundation.	16 days: MO1 would have one day less of flows above 1758 = Negligible decrease compared to the NAA.	16 days: MO2 would have one day less of flows above 1758 = Negligible decrease compared to the NAA.	16 days: MO3 would have one day less of flows above 1758 = Negligible decrease compared to the NAA.	17 days: MO4 would not differ from the NAA.	Off-channel habitats are important for larval and juvenile burbot in the Meander Reach (Bonners Ferry to Kootenay Lake). These habitats provide warmer water, cover, and food, and also may provide nutritional (zooplankton) sources for the mainstem Kootenai River. Seasonal access to off-channel habitats is important for burbot, as well as for Ecosystem and Riparian function. All MO medians of days of floodplain connectivity are similar to those of the NAA, suggesting that ALL MOs would operate similar to the NAA in terms of connectivity. It is likely larval and juvenile burbot would benefit from even longer durations of inundation by providing access to larval rearing habitats and prey sources.

Affected Environment Important Relationships/Criteria	Affected Environment Metric	Environmental Consequences NAA	Environmental Consequences MO1	Environmental Consequences MO2	Environmental Consequences MO3	Environmental Consequences MO4	Notes
Winter Libby Dam discharge regime needs to be low, steady flow, and cold temperature.	BONNERS FERRY FLOW variability between 01 January and 30 April	NAA provides BONNERS FERRY FLOW: MEAN: 9.89 kcfs (18.99 to 6.50) NAA Median DOES NOT provide appropriate discharge regime for successful burbot recruitment; however, it is unknown if river flow is the single factor limiting burbot recruitment (Too much variability).	MO1 Median 11.62 (17.76 - 8.50) MO1 and MO4 appear to be the most stable flow schedules likely to imitate pre-dam hydrographs; therefore, these two MOs would be preferred.	MO2 Median 8.50 (21.02 - 5.37) MO2 and MO3 show greater flow variability relative to the NAA and would have greater impacts to burbot than MO1 and MO4.	MO3 Median 8.50 (21.02 - 5.37) MO2 and MO3 show greater flow variability relative to the NAA and would have greater impacts to burbot than MO1 and MO4.	MO4 Median 11.34 (16.49 - 8.50) MO1 and MO4 appear to be the most stable flow schedules likely to imitate pre-dam hydrographs; therefore, these two MOs would be preferred.	High and variable flows result in interrupted spawning migrations. Low (4kcfs) and stable winter flows = spawning congregations (based on empirical catch rates). Daily load shaping and load following results in high and variable flows, leading to potential for interrupted spawning migrations of adult burbot, which may then further inhibit successful recruitment. Further and more recent data need to be collected to confirm this with the recent increases in burbot densities. Power generation on coldest days results in higher flows, whereas it is believed burbot need lower, more stable flows on the colder days. Pre-dam flows and temperatures in the Kootenai River from November-March were low, stable, and cold. As such, temperature and flow patterns that mimic pre-dam conditions are desirable.

Affected Environment Important Relationships/Criteria	Affected Environment Metric	Environmental Consequences NAA	Environmental Consequences MO1	Environmental Consequences MO2	Environmental Consequences MO3	Environmental Consequences MO4	Notes
Temperature Effects							
Temperature for life history physiology Mid-Feb: 2°C - spawning, egg incubation/survival Mid-March: 6°C - lethal egg incubation, stimulate egg hatch at appropriate time Mid-April: 8°C - proper body development Mid-May: 10°C - growth Mid-June: 12°C - growth End-June: 14°C - growth	MEAN MONTHLY RESERVOIR TEMPERATURE influences MEAN MONTHLY BONNERS FERRY TEMPERATURE	NAA Medians FEB: 2.83°C MAR: 3.83°C APR: 5.65°C MAY: 8.29°C JUN: 11.08°C JUL: 13.54°C NAA Does not provide appropriate mean monthly temperatures at Bonners Ferry for physiological progression of burbot. Early winter temperature is often too warm for spawning and egg development, and can be lethal to eggs at 6°C. Spring temperature is too cold to allow for proper body development, growth, and survival.	MO1 Medians 2.83°C 3.83°C 5.65°C 8.32°C 10.85°C 13.56°C Does not differ from the NAA.	MO2 Medians 2.83°C 3.83°C 5.65°C 8.32°C 10.80°C 13.26°C Does not differ from the NAA.	MO3 Medians 2.83°C 3.83°C 5.65°C 8.35°C 10.91°C 13.21°C Does not differ from the NAA.	MO4 Medians 2.83°C 3.83°C 5.65°C 8.35°C 10.91°C 13.21°C Does not differ from the NAA.	Current spring temperatures are too cold for good productivity. March, April, June colder than historic values. Development is slow, not enough zooplankton to feed, and starve within 7 to 10 days of hatch. Very significant mortality in many years. Pre-dam temperatures in the Kootenai River were consistently cold in the winter months (i.e., November-March) and the sharply rose in the spring (i.e., April, May, and June). This thermograph provided suitable temperature for burbot spawning and egg incubation in the winter, followed by suitable temperatures for larval development and feeding in the spring and summer.
Kokanee							
Reservoir Discharge Effects							
Higher and prolonged early spring Libby Dam flow for riverine ecosystem function mid-March through mid-May.	Departure from pre-dam (1943-1972) rate of LIBBY DAM FLOW increase (425.7 cfs/day) 15 March - 15 May	Rate of LIBBY DAM FLOW increase of 157 (50 - 295) cfs/day between mid-March and mid-May NAA rate of spring freshet flow increase provides ~ 1/3 of the pre-dam mean rate of flow increase.	99 (-2 - 238) C10cfs/day MO1 rates of spring freshet flow increase are lower than the NAA (Decreases in river productivity).	93 (18 - 223) cfs/day MO2 rates of spring freshet flow increase are lower than the NAA (Decreases in river productivity).	93 (18 - 224) cfs/day MO3 rates of spring freshet flow increase are lower than the NAA (Decreases in river productivity).	104 (-2 - 249) cfs/day MO4 rates of spring freshet flow increase are lower than the NAA (Decreases in river productivity).	During this period, it is critical for river flow and stage to rise and inundate riparian and side channel habitat to commence and sustain ecosystem productivity. Delay in commencement of river productivity is detrimental to ALL species and ALL life stages, and prevents establishment of self-sustaining populations of endangered, threatened, and sensitive fish species due to impacts to physiological development.

Affected Environment Important Relationships/Criteria	Affected Environment Metric	Environmental Consequences NAA	Environmental Consequences MO1	Environmental Consequences MO2	Environmental Consequences MO3	Environmental Consequences MO4	Notes
Reservoir Discharge Effects							
Entrainment of young-of-year and adult kokanee through Libby Dam. Peak entrainment densities can occur early spring into mid-summer, and during fall through early winter. Higher discharge entrains more fish.	MEAN LIBBY DAM FLOW between: 1) 15 April and 15 July; and 2) 01 October and 31 December	NAA MEAN LIBBY DAM FLOW: 1) 10.5 - 16.8 kcfs 2) 8.8 - 13.3 kcfs Under the NAA an unknown number of Kokanee would be entrained in spring and fall releases.	1) 9.4 - 16.1 2) 9.6 - 12.1 MO1 would decrease flows in these periods but would have a negligible impact relative to the NAA.	1) 8.7 - 15.6 2) 13.4 - 15.8 MO2 would decrease flows in the spring, but increase it in the fall and would have a negligible impact relative to the NAA.	1) 8.7 - 15.6 2) 13.4 - 15.8 MO3 would decrease flows in the spring, but increase it in the fall and would have a negligible impact relative to the NAA.	1) 9.9 - 16.7 2) 7.3 - 11.7 MO4 would not differ from the NAA in spring flows, but would decrease fall flows. These changes would have a negligible impact relative to the NAA.	Peak rates of entrainment of kokanee are not precisely quantifiable, but pass through Libby Dam during early spring through mid-summer, and during fall through early winter, was documented by Skaar (1996). Entrainment is believed to be beneficial to kokanee upstream of the dam related to density dependency effects. Kokanee are a food source for bull trout and rainbow trout upstream and downstream of the dam.
Bull Trout							
Reservoir Elevation Effects							
Libby Dam elevation during summer months determines area of euphotic zone related to reservoir productivity. Higher elevation = more productivity.	Number of days KOOCANUSA ELEVATION is > 2450' 15 June through 15 September	NAA provides 44 days (range of 0 - 66 for 25 and 75%) of Koocanusa elevation > 2450' during the summer period of productivity (15 June to 15 September).	51 (43-68) Provides 7 days more than the NAA. The expected result would be minor increase in productivity and increased food web for MO1.	46 (18-66) Provides 2 days more than NAA - Negligible increase in productivity	46 (18-66) Provides 2 days more than NAA - Negligible increase in productivity	33 (0-59) Provides 11 days less than NAA - moderate reduction in productivity	Higher lake elevations in the warm summer months provides a larger body of warm euphotic zone for primary production and zooplankton production. Bull trout food base relies on this production for food the following winter. The expected result may be increased primary and secondary production that would likely positively impact bull trout growth and/or survival.
Minimum Libby Dam elevation in one year influences insect larvae production the following year. Lower drafts limit production the following year.	MINIMUM LIBBY ELEVATION (typically in mid-April)	NAA MINIMUM KOOCANUSA ELEVATION is 2366' (median) 2320' -2408' (25 and 75%).	2364 (2327-2406) Lower Draft by 2 foot compared to NAA - negligible change in productivity	2359 (2328-2392) Lower Draft by 7 feet compared to NAA - Minor reduction in productivity	2359 (2328-2392) Lower Draft by 7 feet compared to NAA - Minor reduction in productivity	2366 (2329-2407) No change from the NAA	Benefits to bull trout would likely be limited to juvenile bull trout prior to their switch to a piscivorous diet. Maximum elevation draft in one year affects insect larvae production the following year. All MO's may decrease bull trout growth and/or survival. However, in all cases the 25th percentile is higher for the MO's - More benefit on high water years.
Maximum Libby Dam elevation is related to volume and surface area, as well as to proximity of the surface to terrestrial deposition. Higher elevation = more terrestrial productivity.	MAXIMUM LIBBY ELEVATION (typically early-August)	NAA MAXIMUM KOOCANUSA ELEVATION is 2451 feet median and 2449 -2455 (75 and 25%)	2453 (2452 - 2456) Maximum elevation is 2 foot higher than NAA - Minor increase in shoreline contribution to productivity.	2452 (2450 - 2456) Maximum elevation is 1 foot higher than NAA - Negligible increase in shoreline contribution to productivity.	2452 (2450 - 2456) Maximum elevation is 1 foot higher than NAA - Negligible increase in shoreline contribution to productivity.	2451 (2447 - 2456) No change from the NAA	This metric was not effective in separating the alternatives. MO1 provides the most promise for terrestrial inputs.

*Columbia River System Operations Environmental Impact Statement
Appendix E: Fish, Aquatic Macroinvertebrates, and Aquatic Habitat*

Affected Environment Important Relationships/Criteria	Affected Environment Metric	Environmental Consequences NAA	Environmental Consequences MO1	Environmental Consequences MO2	Environmental Consequences MO3	Environmental Consequences MO4	Notes
Reservoir Flow Effects							
Bull trout weighted usable area in the Kootenai River for juvenile bull trout during the night-time hours is maximized at 4,000 cfs discharge from Libby Dam. Juvenile bull trout weighted usable area during daylight hours and adult bull trout weighted useable area (day and night) are both maximized at 5,000 cfs discharge.	Weighted usable area (square miles) for juvenile (day and night) and adult bull trout based on the mean discharge for the period May 15 to Sept 30 for the median, 25th, and 75th percentiles.	The NAA has a mean flow of 12,388 cfs (median) and flows of 14,445 and 10,301 cfs for the 25 and 75th percentiles from May 15 to Sept 30. WUA in square meters. WUA JuvBTNight: 489,188 WUA JuvBTDay: 1,282,860 WUA AduBTDay: 1,488,901	12,081 cfs (median) and 14,194 and 9,758 cfs (25 and 75%) WUA JuvBTNight: 500,336 WUA JuvBTDay: 1,303,385 WUA AduBTDay: 1,505,322 MO1 would increase WUA by between 1% to 2% = negligible increase	11,700 cfs (median) and 13,842 and 9,281 cfs (25 and 75%) WUA JuvBTNight: 514,173 WUA JuvBTDay: 1,328,856 WUA AduBTDay: 1,525,701 MO2 would increase WUA by between 2-5% = Minor increase	11,698 cfs (median) and 13,840 and 9,281 cfs (25 and 75%) WUA JuvBTNight: 514,245 WUA JuvBTDay: 1,328,990 WUA AduBTDay: 1,525,808. MO3 would increase WUA by between 2-5% = minor increase	13,109 cfs (median) and 15,602 and 10,362 cfs (25 and 75%) WUA JuvBTNight: 465,603 WUA JuvBTDay: 1,227,555 WUA AduBTDay: 1,441,128. MO4 would decrease WUA by between 3-5% = minor decrease	Lower usable weighted habitat may result in reduced growth and/or survival of all life stages of bull trout. Weighted usable area decreases with increasing discharge for all relationships above the maximums. Nearly all riffles, which provide the most productive benthic insect habitat, are inundated at 9 kcfs.
Food availability/off-channel inundation and connectivity is optimized at Libby Dam flow of 9 kcfs to 12 kcfs.	MEAN LIBBY DAM FLOW during bull trout minimum flow requirement period (15 May through 30 September)	NAA provides a MEAN LIBBY DAM DISCHARGE flow of 10.7 - 15.1 kcfs during bull trout minimum flow requirement period (15 May through 30 September). NAA would provide flows that are up to 26% greater than optimum flows.	10.2 - 14.9 kcfs MO1 would provide flows up to 2% less than the NAA = Negligible positive change.	9.7 - 14.5 kcfs MO2 would provide flows up to 5% less than the NAA = Minor positive change.	9.7 - 14.5 kcfs MO3 would provide flows up to 5% less than the NAA = Minor positive change.	10.8 - 16.4 kcfs MO4 would provide flows up to 10% more than the NAA = Minor negative change.	Decreased productivity would occur outside inundation optimums.
Libby Dam flow fluctuations during the winter impact benthic ecology.	Daily flow shape	NO DATA are available to assess within day variability	NA	NA	NA	NA	Current winter operations (relaxed ramping rates) allow for varial zone desiccation, re-inundation, and freezing. May impact species bioenergetics - increased metabolic activity. Winter load shaping/following is deleterious to benthic ecology.
Maximum Libby Dam flow (?20 kcfs) is needed seasonally to flush and sort fine sediments and gravels. The typical rule of thumb for channel maintenance and gravel sorting is “bankfull flow for at least 48 hours on a periodicity of 2.5 years.”	Peak (?20 kcfs) Libby Dam flow during freshet period (15 May through 15 June).	NAA provides 13 (11 to 16) days of LIBBY DAM FLOW > 20 kcfs; mean flow is 18.8 (18.2 to 20.8) kcfs peak is 24.4 (23.1 to 26.9) kcfs	12 (0 - 20) days 18.0 (16.4 - 20.5) kcfs 23.7 (23.0 - 26.9) kcfs MO1 would provide decreases between 3% and 7% in metrics that measure sediment movement - negligible decrease in delta movement.	11 (9 - 15) days 17.4 (14.5 - 20.3) kcfs 23.3 (23.0 - 27.0) kcfs MO2 would provide decreases between 5% and 15% in metrics that measure sediment movement - Minor decrease in delta movement.	11 (9 - 15) days 17.4 (14.5 - 20.3) kcfs 23.3 (23.0 - 27.0) kcfs MO3 would provide decreases between 5% and 15% in metrics that measure sediment movement - Minor decrease in delta movement.	12 (10 - 16) days 18.4 (16.6 - 20.7) kcfs 24.0 (22.8 - 27.0) kcfs MO4 would provide decreases between 2% and 7% in metrics that measure sediment movement - negligible decrease in delta movement.	Higher flows - up to 25 kcfs, for a higher duration - up to 30 days, are desired. These higher flows are insufficient to remove tributary delta aggradation that can prevent bull trout access to natal tributaries during spawning season. The peak discharge of all MO's, as well as the NAA, are insufficient to remove tributary delta aggradation that can prevent bull trout access to natal tributaries during spawning season.

Affected Environment Important Relationships/Criteria	Affected Environment Metric	Environmental Consequences NAA	Environmental Consequences MO1	Environmental Consequences MO2	Environmental Consequences MO3	Environmental Consequences MO4	Notes
Temperature Effects							
RESERVOIR TEMPERATURE influences habitat suitability, surface elevation and reservoir volume influence thermal structure of pool. Fish seek preferred temps; volume of temperature range influences amount of habitat available. Bull trout optimal growth occurs at 55.8 F. The upper incipient lethal temperature for bull trout is 69.7 F.	MEAN MONTHLY RESERVOIR TEMPERATURE influences LIBBY DAM DISCHARGE TEMPERATURE	Mean Monthly Reservoir Temperature: JAN: 40.88°F FEB: 38.97°F MAR: 38.32°F APR: 38.83°F MAY: 43.20°F JUN: 48.50°F JUL: 51.40°F AUG: 52.45°F	40.88°F 38.97°F 38.32°F 38.83°F 43.25°F 48.10°F 51.30°F 52.35°F No change from NAA	40.88°F 38.97°F 38.32°F 38.83°F 43.30°F 48.20°F 50.80°F 52.35°F No change from NAA	40.88°F 38.97°F 38.32°F 38.83°F 43.30°F 48.20°F 50.80°F 52.35°F No change from NAA	40.88°F 38.97°F 38.32°F 38.83°F 43.25°F 48.00°F 50.90°F 52.80°F change from NAA	Reservoir temperature (Dunnigan, unpublished) is determined by several variables, the most indicative of which are volume of the reservoir through the winter (as measured by minimum pool elevation in April), inflow, and air temperature. The estimated temperature differences for all MO's are very small, and are all below the optimal growth temperature and upper incipient lethal temperature during all months.
LIBBY DAM DISCHARGE TEMPERATURE is manageable seasonally when the reservoir stratifies (non-isothermic conditions) via a Selective Withdrawal system to provide normative discharge temperatures. Bull trout optimal growth occurs at 55.8 F. The upper incipient lethal temperature for bull trout is 69.7 F.	MEAN MONTHLY RESERVOIR TEMPERATURE influences MEAN MONTHLY DISCHARGE TEMPERATURE	Mean Monthly Reservoir Temperature: JAN: 40.88°F FEB: 38.97°F MAR: 38.32°F APR: 38.83°F MAY: 43.20°F JUN: 48.50°F JUL: 51.40°F AUG: 52.45°F	40.88°F 38.97°F 38.32°F 38.83°F 43.25°F 48.10°F 51.30°F 52.35°F No change from NAA	40.88°F 38.97°F 38.32°F 38.83°F 43.30°F 48.20°F 50.80°F 52.35°F No change from NAA	40.88°F 38.97°F 38.32°F 38.83°F 43.30°F 48.20°F 50.80°F 52.35°F No change from NAA	40.88°F 38.97°F 38.32°F 38.83°F 43.25°F 48.00°F 50.90°F 52.80°F No change from NAA	Selective Withdrawal system is used to provide normative discharge temperatures as reservoir forebay conditions allow. The estimated temperature differences for All MO's are very small, and are all below the optimal growth temperature and upper incipient lethal temperature during all months.
Westslope Cutthroat Trout							
Reservoir Elevation Effects							
LIBBY ELEVATION during summer months determines area of photic zone related to surface productivity.	Number of days KOOCANUSA ELEVATION is > 2450' 15 June through 15 September	NAA provides 44 days (median) (0-66 days; 25 and 75%) of KOOCANUSA ELEVATION > 2450' during the summer period of productivity (15 June - 15 September)	51 (43 - 68) MO1 provides 16% more days over 2450. The expected result would be a minor increase in productivity and food web connectivity.	46 (18 - 66) No change from the NAA	46 (18 - 66) No change from the NAA	33 (0 - 59) MO4 would result in a 25% decrease in days over 2450. Minor decrease in productivity and food web connectivity would likely negatively impact westslope trout growth and/or survival.	Higher lake elevations in the warm summer months provides a larger body of warm euphotic zone for primary production and zooplankton production. Westslope cutthroat trout food base relies on this production for food the following winter. The expected result may be increased primary and secondary production that would likely positively impact westslope cutthroat trout growth and/or survival.
MINIMUM LIBBY ELEVATION in one year influences insect larvae production the following year where lower drafts are associated with lower production the following year.	MINIMUM LIBBY ELEVATION (typically in mid-April)	NAA MINIMUM KOOCANUSA ELEVATION is 2366' (median) 2320' -2408' (25 and 75%).	2364 (2327-2406) Lower Draft by 2 foot compared to NAA - negligible change in productivity	2359 (2328-2392) Lower Draft by 7 feet compared to NAA - Minor reduction in productivity	2359 (2328-2392) Lower Draft by 7 feet compared to NAA - Minor reduction in productivity	2366 (2329-2407) No change from the NAA	Maximum elevation draft in one year affects insect larvae production the following year. Minimum elevations measure the depth of the draft and acts as a surrogate for area desiccated.

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Appendix E: Fish, Aquatic Macroinvertebrates, and Aquatic Habitat*

Affected Environment Important Relationships/Criteria	Affected Environment Metric	Environmental Consequences NAA	Environmental Consequences MO1	Environmental Consequences MO2	Environmental Consequences MO3	Environmental Consequences MO4	Notes
MAXIMUM LIBBY ELEVATION (May to Sept) is positively correlated to RRT weight growth downstream of Libby Dam.	MAXIMUM LIBBY ELEVATION (typically early-August)	NAA MAXIMUM KOOCANUSA ELEVATION is 2451 median and 2449 - 2455 (25 and 75%)	2453 (2452 - 2456) MO1 would have two additional feet of elevation - Negligible change from the NAA.	2452 (2450 - 2456) MO2 would have one additional foot of elevation - Negligible change from the NAA.	2452 (2450 - 2456) MO3 would have one additional foot of elevation - Negligible change from the NAA.	2451 (2447 - 2456) No change from the NAA.	This metric did not distinguish differences in the alternatives.
MAXIMUM LIBBY ELEVATION is related to volume and surface area, and to proximity of the surface to terrestrial insect deposition - higher elevations are associated with greater terrestrial inputs.	MAXIMUM LIBBY ELEVATION (typically early-August)	NAA MAXIMUM KOOCANUSA ELEVATION is 2451 median and 2449 - 2455 (25 and 75%)	2453 (2452 - 2456) MO1 would have two additional feet of elevation leading to a minor increase in terrestrial inputs and productivity when compared to the NAA.	2452 (2450 - 2456) MO2 would have one additional foot of elevation - Negligible change from the NAA.	2452 (2450 - 2456) MO3 would have one additional foot of elevation - Negligible change from the NAA.	2451 (2447 - 2456) No change from the NAA.	MO1 would have minor increases in terrestrial insect deposition and food resources for juvenile bull trout.
Reservoir Flow Effects							
Rainbow/Redband Trout weighted useable area in the Kootenai River for juvenile and adult trout is maximized at 4,000 cfs discharge from Libby Dam. Weighted usable area decreases with increasing discharge for all relationships above the maximums.	Weighted usable area (sq. m) for juvenile and adult Rainbow/Redband trout based on the mean discharge for the period May 15 to Sept 30 for the median, 25, and 75th percentiles.	The NAA has a mean flow of 12,388 cfs (median) and flows of 14,445 and 10,301 cfs for the 25 and 27th percentiles from May 15 to Sept 30. WUA in square meters. WUA JuvRBRBT: 683,548 WUA AduRBRBT: 680,501	12081 cfs (median) and 14194 and 9758 cfs (25 and 75%) WUA JuvRBRBT: 699,413 WUA AduRBRBT: 703,847 MO1 would increase RBT WUA by between 2-3% = negligible increase in habitat	11700 cfs (median) and 13842 and 9281 cfs (25 and 75%) WUA JuvRBRBT: 719,103 WUA AduRBRBT: 703,847 MO2 would increase RBT WUA by between 3-5% = minor increase in habitat	11698 cfs (median) and 13840 and 9281 cfs (25 and 75%) WUA JuvRBRBT: 719,207 WUA AduRBRBT: 732,974 MO3 would increase RBT WUA by between 5-8% = minor increase in habitat	13109 cfs (median) and 15602 and 10362 cfs (25 and 75%) WUA JuvRBRBT: 649,615 WUA AduRBRBT: 634,688 MO4 would decrease RBT WUA by between 5-7% = minor decrease in habitat	Lower usable weighted habitat may result in reduced growth and/or survival of all life stages of rainbow redband trout.
LIBBY DAM FLOW fluctuations during the winter impact benthic ecology.	Daily flow shape	NO DATA are available to assess within day variability	NA	NA	NA	NA	NAA winter operations (relaxed ramping rates) allow for varial zone desiccation, re-inundation, and freezing. May impact species bioenergetics - increased metabolic activity. Winter load shaping/following is deleterious to benthic ecology. Metric not used - no data available.
SUGGEST Deleting this: MAXIMUM LIBBY DAM FLOW (> 20 kcfs) is needed seasonally to flush and sort fine sediments and gravels.	PEAK (> 20 kcfs) LIBBY DAM FLOW during FRESHET period (15 May through 15 June)	NAA provides 13 (11 - 16) days of LIBBY DAM FLOW > 20 kcfs; mean flow is 18.8 (18.2 - 20.8) kcfs peak is 24.4 (23.1 - 26.9) kcfs	12 (0 - 20) days 18.0 (16.4 - 20.5) kcfs 23.7 (23.0 - 26.9) kcfs MO1 would provide decreases between 3-7% in metrics that measure sediment movement - negligible decrease in delta movement.	11 (9 - 15) days 17.4 (14.5 - 20.3) kcfs 23.3 (23.0 - 27.0) kcfs MO2 would provide decreases between 5-15% in metrics that measure sediment movement - Minor decrease in delta movement.	11 (9 - 15) days 17.4 (14.5 - 20.3) kcfs 23.3 (23.0 - 27.0) kcfs MO3 would provide decreases between 5-15% in metrics that measure sediment movement - Minor decrease in delta movement.	12 (10 - 16) days 18.4 (16.6 - 20.7) kcfs 24.0 (22.8 - 27.0) kcfs MO4 would provide decreases between 2-7% in metrics that measure sediment movement - negligible decrease in delta movement.	Higher flows - up to 25 kcfs, for a higher duration - up to 30 days, are desired. These higher flows are insufficient to remove tributary delta aggradation that can prevent bull trout access to natal tributaries during spawning season. The peak discharge of All MO's is insufficient to remove tributary delta aggradation that can prevent bull trout access to natal tributaries during spawning season.

Affected Environment Important Relationships/Criteria	Affected Environment Metric	Environmental Consequences NAA	Environmental Consequences MO1	Environmental Consequences MO2	Environmental Consequences MO3	Environmental Consequences MO4	Notes
Temperature Effects							
RESERVOIR TEMPERATURE influences habitat suitability, surface elevation and reservoir volume influence thermal structure of pool. Fish seek preferred temps; volume of temperature range influences amount of habitat available. Rainbow and westslope cutthroat trout optimal growth occurs at 55.6°F and 56.5°F, respectively. The upper incipient lethal temperature for rainbow and westslope cutthroat trout is 75.7°F and 67.3°F, respectively.	MEAN MONTHLY RESERVOIR TEMPERATURE influences LIBBY DAM DISCHARGE TEMPERATURE	Mean Monthly Reservoir Temperature: JAN: 40.88°F FEB: 38.97°F MAR: 38.32°F APR: 38.83°F MAY: 43.20°F JUN: 48.50°F JUL: 51.40°F AUG: 52.45°F	40.88°F 38.97°F 38.32°F 38.83°F 43.25°F 48.10°F 51.30°F 52.35°F No change from NAA	40.88°F 38.97°F 38.32°F 38.83°F 43.30°F 48.20°F 50.80°F 52.35°F No change from NAA	40.88°F 38.97°F 38.32°F 38.83°F 43.30°F 48.20°F 50.80°F 52.35°F No change from NAA	40.88°F 38.97°F 38.32°F 38.83°F 43.25°F 48.00°F 50.90°F 52.80°F No change from NAA	Reservoir temperature (Dunnigan, unpublished) is determined by several variables, the most indicative of which are volume of the reservoir through the winter (as measured by minimum pool elevation in April), inflow, and air temperature. The estimated temperature differences for all MO's are very small, and are all below the optimal growth temperature and upper incipient lethal temperature during all months.
LIBBY DAM DISCHARGE TEMPERATURE is manageable seasonally (non-isothermic conditions) via a Selective Withdrawal system to provide normative discharge temperatures. Rainbow and westslope cutthroat trout optimal growth occurs at 55.6°F and 56.5°F, respectively. The upper incipient lethal temperature for rainbow and westslope cutthroat trout is 75.7 and 67.3 F, respectively.	MEAN MONTHLY RESERVOIR TEMPERATURE influences MEAN MONTHLY DISCHARGE TEMPERATURE	Mean Monthly Reservoir Temperature: JAN: 40.88°F FEB: 38.97°F MAR: 38.32°F APR: 38.83°F MAY: 43.20°F JUN: 48.50°F JUL: 51.40°F AUG: 52.45°F	40.88°F 38.97°F 38.32°F 38.83°F 43.25°F 48.10°F 51.30°F 52.35°F No change from NAA	40.88°F 38.97°F 38.32°F 38.83°F 43.30°F 48.20°F 50.80°F 52.35°F No change from NAA	40.88°F 38.97°F 38.32°F 38.83°F 43.30°F 48.20°F 50.80°F 52.35°F No change from NAA	40.88°F 38.97°F 38.32°F 38.83°F 43.25°F 48.00°F 50.90°F 52.80°F No change from NAA	Selective withdrawal system is used to provide normative discharge temperatures as reservoir forebay conditions allow. The estimated temperature differences for all MO's are very small, and are all below the optimal growth temperature and upper incipient lethal temperature during all months.

Dunnigan, unpublished

Skaar, D., J. DeShazer, L. Garrow, T. Ostrowski and B. Thornburg. 1996. Quantification of Libby Reservoir levels needed to maintain or enhance reservoir fisheries - investigation of fish entrainment through Libby Dam, 1990-1994 Final report. Project 83-467 - prepared for Bonneville Power Administration. Montana Fish, Wildlife & Parks, Kalispell, MT. 114 pp.

HUNGRY HORSE/CLARK FORK BASIN

Fish and aquatic resources in the Hungry Horse/Clark Fork basin were evaluated qualitatively. Hydrology and WQ data outputs from models were examined to predict effects using relationships between these parameters and biological responses. These relationships were guided by conceptual ecological models for species in this area and regional/local knowledge of the subteam. These relationships and the effects of the No Action Alternative were developed in a workshop in Kalispell, MT March 12-13, 2019 in Kalispell, MT. The Resident fish team subgroup for this region then met again May 30-31, 2019 in Kalispell, Montana to evaluate the effects of the Multi-Objective alternatives to these resources using the same relationships and compare these effects to the NAA. During this workshop, discussions led to the desire to do some further processing of hydrology data to estimate quantitatively the changes in euphotic zone and surface area of the reservoir at the end of each month under each alternative, as these indicate important relationships between Hungry Horse reservoir elevations and aquatic food sources, which is a driving factor for fish. Changes in surface area were also used as an information proxy to understand the magnitude of change in benthic surface available for insect production as well. Information from these tables were incorporated into the matrix and discussed with the team via follow-up conference calls and correspondence. Hydrology and water quality information used can be found in the pertinent sections of Chapter 3 or the associated technical appendices.

The fish community of Hungry Horse Reservoir is dominated by native fish such as bull trout, westslope cutthroat trout, and mountain whitefish, and the most important drivers are related to food production, which affects all fish. The team developed relationships and NAA effects for some other species in different spreadsheets, but noticed considerable overlap with bull trout. For the action alternatives the team decided to discuss analyses of all fish at the same time and these were compiled all in the bull trout tab, with notations there when a particular relationship applied to a different species differently, such as the difference in spawning run timing for tributary access affects. . Likewise, the fish resources downstream of Hungry Horse were minimally affected by changes in the alternatives and, again, the relationships apply more on a habitat scale rather than by species. Therefore, there is only one matrix for this area with discussions weighted to bull trout but covering all species. The matrix considers resources starting with Hungry Horse Reservoir and working downstream through the South Fork of the Flathead River, mainstem Flathead River, Flathead Lake, the lower Flathead River (below Flathead Lake), and the Clark Fork River. Non-native species become more prevalent in the downstream reaches of the basin.

After completing these analyses, the team received notification that there was an error in the hydrology data provided to the fish team. Without sufficient time to re-run the hydrology and adjust the analyses quantitatively, a description of the error was provided by the hydrology team and used to qualitatively adjust the conclusions in the fish analyses described in Chapter 3.5. All elevation data, euphotic zone calculations, and surface area calculations in these tables are from the original model runs. It should be noted that when Alternatives MO1 and MO3 were modeled, the initial Hungry Horse Reservoir levels at the start of each water year were

erroneously set lower than intended. A subsequent sensitivity analysis revealed that this initialization error primarily affected results in the fall and winter. This initialization error causes the Alternative MO1 results to be too low during the fall and winter. In the summary hydrograph shown above, years at the median and higher elevations should have water levels 1-3 feet higher than shown from October through May. For years with reservoir elevations lower than the median elevation, the results should be 5-10 feet higher from October through February. This initialization error had little effect downstream from Hungry Horse Dam. Hungry Horse Dam's modeled releases were up to 1 kcfs lower than they should have been, but by the time flow reaches Flathead Lake the MO1 results have little error.

As in all resources, a matrix was used to capture the environmental relationships, the metric to evaluate it, and then data, effects, and notes for each of the alternatives, including the NAA. The information in the matrix was condensed into the matrix in this section. Following the matrix, tables display the outcome of the additional euphotic zone and surface elevation information developed, including the volume and surface area, the change from NAA of each, and the percent change. These values were reported and discussed in the text of Chapter 3.5.

Table 3-69. Flathead/Clark Fork Qualitative Effects Analysis Matrix Part 1

Affected Environment Important Relationships / Criteria	Environmental Consequences Metric	Environmental Consequences NAA	Environmental Consequences MO1	Environmental Consequences MO2	Environmental Consequences MO3	Environmental Consequences MO4	Notes																																				
Bull Trout																																											
Hungry Horse Reservoir																																											
–	–	Most important relationships are related to productivity (food source for all fish in the reservoir, including bull trout). Several relationships are defined that are interrelated. Hungry Horse Reservoir has no known water quality issues. The reservoir is an oligotrophic water body with high water quality. It is located high in the watershed. Few processes are likely to influence water quality with respect to nutrients and/or sediment. These processes include: forestry operations, road building, natural disasters (e.g. forest fires) and atmospheric deposition. 2500-10000 bull trout, stable, limited harvest fishery. http://docs.streamnetlibrary.org/BPA_Fish_and_Wildlife/12659-5.pdf. Is food the limiting factor - driver is likely successful reproduction, but food availability is important in the reservoir.	Most important impacts from lower water levels at Hungry Horse from water supply measure. Half of years, Sep 30 elevation at least 4 feet lower. In 10% of years, 4 feet to 16 feet deeper draft. Sliding scale measure - driest years provides additional water supply (4 feet), sliding scale, then meet minimum flows. Lower releases most of year to support higher releases Aug and Sep.	Additional outflow for power generation results in much higher outflows in January and deeper drafts in winter (Dec to Apr); median elevations 4 feet to 8 feet lower than NAA. Sliding scale reduces occurrences of drafts to 20 feet in extremely low elevations, with some years going to somewhere between 10 feet and 20 feet instead that would have drafted clear to 20 feet under NAA. Relaxed ramping rate restrictions could result in more drastic day to day and within day fluctuations. Outflow changes promulgate downstream but attenuated as flows join Flathead River and are passed through Flathead Lake. Note: Modeling assumed flows passed through Flathead Lake, but operators could choose to store that water and release differently.	Very similar to MO1 - See Elev. Fcst_Comparisons	In drier half of years up to 10 feet to 15 feet lower Hungry Horse elevation. Average years and above are similar to MO1.	http://dnrc.mt.gov/divisions/reserved-water-rights-compact-commission/docs/cskt/2011_hhbiologicalconstraintsreport.pdf																																				
Hungry Horse Reservoir elevations affect production of phytoplankton, zooplankton, and invertebrates that are the base of the food source for bull trout in three ways: 1) Higher lake elevations in the warm summer months provide a larger body of warm euphotic zone for primary production and zooplankton production. Lower elevations = lower production. 2) Higher elevations = more areas of benthic substrate in the zone that	Hungry Horse Reservoir elevation duration monthly: Jun, Jul, and Aug; and probability of reaching target pool elevation Jul 30. Elev_Fcst_Comparison-2019_0408 elevation on Jun 30 average, dry, wet year types. Rate of refill to full pool, duration at/near full before drawdown. Duration at maximum elevation.	<table><tr><th colspan="2">Jun</th><th colspan="2">Jul</th></tr><tr><td>50%</td><td>3551.21</td><td>50%</td><td>3559.17</td></tr><tr><td>60%</td><td>3548.08</td><td>60%</td><td>3558.59</td></tr><tr><td>70%</td><td>3544.14</td><td>70%</td><td>3557.36</td></tr><tr><td>80%</td><td>3539.07</td><td>80%</td><td>3555.70</td></tr><tr><td>90%</td><td>3529.94</td><td>90%</td><td>3552.97</td></tr></table> <table><tr><th colspan="2">Aug</th></tr><tr><td>50%</td><td>3556.21</td></tr><tr><td>60%</td><td>3555.58</td></tr><tr><td>70%</td><td>3554.68</td></tr><tr><td>80%</td><td>3552.50</td></tr><tr><td>90%</td><td>3551.019</td></tr></table> Probability of exceeding 3559 by Jul 30 = 0.75. Jun 30 Elevation Ave: 3558.78	Jun		Jul		50%	3551.21	50%	3559.17	60%	3548.08	60%	3558.59	70%	3544.14	70%	3557.36	80%	3539.07	80%	3555.70	90%	3529.94	90%	3552.97	Aug		50%	3556.21	60%	3555.58	70%	3554.68	80%	3552.50	90%	3551.019	High years: About 4 feet lower by end of Sep Ave: About 4 feet lower by end of Sep Dry: About 1 foot lower end of Sep. Very dry (10%) 4 feet to 16 feet lower. Probability of exceeding 3559 by Jul 30 = 0.69 Jun 30 Elev Ave: 3558.62 Jun 30 Elev Dry: 3557.15 Jun 30 Elev Wet: 3553.15 Jul 31 Elev Ave: 3558.26 Jul 31 Elev Dry: 3553.45 Jul 31 Elev Wet: 3559.11 Aug 31 Elev Ave: 3552.5 Aug 31 Elev Dry: 3546.26 Aug 31 Elev Wet: 3553.24 Through the summer, drops 4 feet lower than NAA, the body of euphotic zone for primary	Same as NAA until Nov, then deeper draft in winter, up to 10 feet lower Dec to late April. Wet and average years same as NAA; Dry years lower in Jun to Jul, higher in Aug. Jun 30 Elev Ave: 3558.07 Jun 30 Elev Dry: 3555.18 Jun 30 Elev Wet: 3553.92 Probability of 3559 feet by Jul 31 = 67% See elevation comparisons. Dry years - flatter slope. Ave/wet - same as NAA. Drastically reduced substrate for insect production, large bays could be dewatered. Insects that would have been overwintered for following season would be not available. These insects are important spring food	See Elev_Fcst_Comparisons Same as MO1. Probability of exceeding 3559 by Jul 30 = 0.75 Jun 30 Elev Ave: 3558.68 Jun 30 Elev Dry: 3556.21 Jun 30 Elev Wet: 3553.62 Same as MO1.	High years: About 4 feet lower by end of Sep Ave: About 4 feet lower by end of Sep Dry: About 10 feet to *15 feet lower end of Sept. Very dry (10%) 4 feet to 16 feet lower. Jun 50% = 3549.70 (-1.5) 60% = 3546.23 (-1.8) 70% = 3542.18 (-2.0) 80% = 3536.87 (-2.2) 90% = 3528.13 (-1.8) Jul 50% = 3558.87 (-0.3) 60% = 3558.13 (-0.5) 70% = 3556.88 (-0.5) 80% = 3554.9 (-0.8) 90% = 3551.27 (-1.7)	Flathead Subbasin plan, reference section. Wiseman et al., 2016 - Gila River report RIVBIO model (Brian e-copy) Potential mitigation - revegetate the top 10 feet of reservoir. Experimental - planted willows, would survive submerged for 43 days (Example) create a new insect source, and security cover for fish when inundated. When above water, there are wildlife benefits and terrestrial insect production for fish. (Marotz) Water supply modeled to all come out in Jun, Jul, Aug. In reality would likely be delivered more spread out.
Jun		Jul																																									
50%	3551.21	50%	3559.17																																								
60%	3548.08	60%	3558.59																																								
70%	3544.14	70%	3557.36																																								
80%	3539.07	80%	3555.70																																								
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Aug																																											
50%	3556.21																																										
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Affected Environment Important Relationships / Criteria	Environmental Consequences Metric	Environmental Consequences NAA	Environmental Consequences MO1	Environmental Consequences MO2	Environmental Consequences MO3	Environmental Consequences MO4	Notes
supports aquatic insect production. Lower elevations reduces benthic insects. Maximum elevation draft in 1 year affects insect larvae production the following year. Shape of refill/drawdown also affects insect production; gradual slopes maximize productivity compared to faster refill or drawdown (better to miss full than to fill quickly, “touch” full pool, then drawdown again. 3) Elevations influence availability of terrestrial insects; lower elevations provide less surface area to collect insects, and the water surface becomes further from the terrestrial vegetation at lower lake levels.		Jun 30 Elevation Dry: 3558.50 Jun 30 Elevation Wet: 3553.15 Jul 31 Elevation Ave: 3558.90 Jul 31 Elevation Dry: 3554.10 Jul 31 Elevation Wet: 3559.40 Aug 31 Elevation Ave: 3554.80 Aug 31 Elevation Dry: 3547.20 Aug 31 Elevation Wet: 3555.50 Current management is to try to reach full pool (Elevation 3560) by early summer to provide adequate primary productivity. Bull trout food base relies on this production for food the following winter. This would continue to provide an adequate food source for winter supply of zooplankton that fuels the food web. 1) Zooplankton is important winter food source. In the biologically-productive warm months, want the reservoir as full as possible. Gives large body of warm euphotic zone for primary production; zooplankton production. 2) Aquatic inverts important spring food source. Benthic substrate is important for aquatic inverts production. The deeper the max drawdown, the worse the spring food supply from benthic productivity. Benthic production occurs in a zone between area wetted long enough to produce, down to where too deep for light to penetrate. Fast filling/drawdown retards productivity. Even at full pool, the substrate is wet but needs to stay wet 5 to 7 weeks in order to be productive - populate with plants, then inverts move in. If dewater before this process completes there is no benefit to production. 3) Terrestrial insects important summer food source. Bull trout piscivorous - on mountain whitefish, suckers,	production would be smaller through the warm summer months, and then in winter months would be up to 9 feet lower through winter months. Drastically reduced substrate for insect production, large bays could be dewatered. Insects that would have been overwintered for following season would be not available. These insects are important spring food source. Reduced benthic food production. See MO2 notes for quantification estimate method. Deeper draft increases the area that gets dewatered in most years by 4 feet in summer months and up to 16 feet in 20% of years (dry years). Effect to bull trout is indirect effect to prey base for adults (suckers, whitefish, peamouth, westslope cutthroat trout, pikeminnow). Juvenile bull trout moving into reservoir in spring, eating insects until transition to fish. The prey base impacted until that transition. Expect poorer condition and reduced populations of prey base fish and juvenile bull trout. Deeper drawdown in winter/spring dewater larvae. Fail to refill, so less volume available for productivity. Pulled back further from the riparian vegetation don't land on the water.	source. Reduced benthic food production. See notes for quantification estimate method. Deeper draft increases the area that gets dewatered every year by 8 feet. Insects all desiccated when sampled in dewatered zones. 2-yr life cycle insects (big midges most valuable for fish) would be most affected because of 2-yr life cycle. Insects exist is a "bell curve" according to depth. Effect to bull trout is indirect effect to prey base for adults (suckers, whitefish, peamouth, westslope cutthroat trout, pikeminnow). Juvenile bull trout moving into reservoir in spring, eating insects until transition to fish. The prey base impacted until that transition. Expect poorer condition and reduced populations of prey base fish and juvenile bull trout. Deeper drawdown in winter/spring dewater larvae. Fail to refill, so less volume available for productivity. Pulled back further from the riparian vegetation don't land on the water.		Aug 50% = 3554.57 (-1.64) 60% = 3553.83 (-1.75) 70% = 3553.04 (-1.64) 80% = 3551.81 (-0.7) 90% = 3548.44 (-2.58) Probability of exceeding 3559 by Jul 30 = 0.65 Jun 30 Elev Ave: 3558.62 Jun 30 Elev Dry: 3557.15 Jun 30 Elev Wet:3553.15 Jul 31 Elev Ave: 3558.26 Jul 31 Elev Dry:3553.45 Jul 31 Elev Wet: 3559.11 Aug 31 Elev Ave: 3552.5 Aug 31 Elev Dry:3546.26 Aug 31 Elev Wet: 3553.24 Jun 30 Elev Ave: 3558.40 Jun 30 Elev Dry: 3550.19 (8.31 feet lower) Jun 30 Elev Wet: 3553.15 Wet and Average years: About 5 feet lower than NAA, and about 1 foot lower than MO1. Effects would be similar to MO1, only a little bit higher magnitude. (5 feet lower instead of 4 feet lower). Dry years: 10-foot to 15-foot drop in elevation. Decrease in warm euphotic zone and benthic substrate production. Mitigation - reshape flow regime to pay back Coulee water in McNary measure to be less detrimental. NOTE: per our notes, I have info converting surface elevation to volume and surface area. Need to chat about the findings.	Water is for industrial, municipal, and irrigation Fish eating pupae, a more gradual drawdown would provide benefit for longer, and potentially aquatic insects could move to deeper locations (larvae may Steeper slope would exacerbate this effect: Potential mitigation - fill slower, don't get as high, but better to miss full and drawdown slower. July start drafting for multipurposes plus new purpose of water supply. Up to 80% years, runs lower than NAA directly. In drier years, 80% to 90%, the sliding scale offsets some of the impact, but beyond 90% driest years the impact shows again. In most years, recover that storage in refill, but in drier years may miss full the following year more often. Ending water year lower results in drafting further to support the same minimum flows. End up deeper in the following spring. Eric - modeling did adjust to capture carryover effect in exceedance graphs. Use "Elevation Duration Monthly tab" Mitigation thoughts - Subimpoundments in headwaters of reservoirs (Palisades) create berms to hold water longer and revegetation (issues - habitat for nonnative fish, build below full pool so water floods over them, with no egress) Install woody debris reefs to provide habitat for aquatic inverts. Mitigation ideas? Can create more surface area with submerged structures, but wary

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		minnows, etc. Prey fish all rely on the food web relationships described above.					of public safety issues. Or sink Christmas trees. Manage (reduce) introgression of rainbow/westslope cutthroat trout; reduce overlap of spp. in Flathead River. Opportunities to expand westslope cutthroat trout populations in secure refugia (currently have non-natives)																																																																																															
Follow-up quantification of food production analyses. Notes of 7/2/19. Not a separate analyses, but puts some quantification to the analyses in row above. End of month elevations (from elevation comparison tool) in wet, dry, and average years were converted to volume, then the volume of the non-productive deep part of the reservoir subtracted (see NAA notes). Note: Euphotic zone only refers to the productivity in summer part of the relationships described in Row 8. Insect production and surface area for terrestrial production captured in next 2 rows.	Euphotic zone	Volume of euphotic zone in acre-feet:	Change in volume of euphotic zone, compared to NAA. Quantification to inform effects.	Change in volume of euphotic zone, compared to NAA. Quantification to inform Row 9 effects.	Change in volume of euphotic zone, compared to NAA.	Change in volume of euphotic zone, compared to NAA. Quantification to inform effects.	Use volume to estimate euphotic zone loss. (Zooplankton - important for prey species and juvenile bull trout). May reports have isopleth diagrams showing how thick the thermocline is. Estimate June (with selective withdrawal starts) about 20 feet thick, Jul about 30 feet, Aug about 50 feet, Sep (prior to turnover) about 65 feet thick. Substrate for benthic production (important all year, but the most important food in spring) use elevation to surface area, have to assume continuous even slope, for an index of substrate habitat lost. Terrestrial insect deposition - proportional to surface area lost for all 4 insect orders. Two of the orders don't fly so lose more due to being further from the surface elevations. Coleopterans (beetles) and homopterans (leafhoppers). Lose contribution to fish food supply because fall close to shoreline vegetation (don't fly). Hymenopterans (very important summer food source) and hemipterans fly well so don't have that effect but rather are proportional to surface area. Coleopterans are main food supply during summer.																																																																																															
		<table><tr><th>NAA Wet Year</th><th>NAA Dry Year</th><th>NAA Avg Year</th><th>Month</th></tr><tr><td>510997</td><td>635389</td><td>607725</td><td>May</td></tr><tr><td>645447</td><td>662074</td><td>662913</td><td>Jun</td></tr><tr><td>1057686</td><td>1030354</td><td>1055107</td><td>Jul</td></tr><tr><td>1376345</td><td>1316650</td><td>1371494</td><td>Aug</td></tr><tr><td>1489407</td><td>1408156</td><td>1489248</td><td>Sep</td></tr></table>	NAA Wet Year	NAA Dry Year	NAA Avg Year	Month		510997	635389	607725	May	645447	662074	662913	Jun	1057686	1030354	1055107	Jul	1376345	1316650	1371494	Aug	1489407	1408156	1489248	Sep	<table><tr><th></th><th>Wet</th><th>Dry</th><th>Avg</th></tr><tr><td>May</td><td>0%</td><td>-3%</td><td>-1%</td></tr><tr><td>Jun</td><td>0%</td><td>-1%</td><td>0%</td></tr><tr><td>Jul</td><td>0%</td><td>0%</td><td>0%</td></tr><tr><td>Aug</td><td>-1%</td><td>-1%</td><td>-1%</td></tr><tr><td>Sep</td><td>-2%</td><td>-1%</td><td>-2%</td></tr></table>		Wet	Dry	Avg	May	0%	-3%	-1%	Jun	0%	-1%	0%	Jul	0%	0%	0%	Aug	-1%	-1%	-1%	Sep	-2%	-1%	-2%	<table><tr><th></th><th>Wet</th><th>Dry</th><th>Avg</th></tr><tr><td>May</td><td>0%</td><td>-3%</td><td>-1%</td></tr><tr><td>Jun</td><td>0%</td><td>-1%</td><td>0%</td></tr><tr><td>Jul</td><td>0%</td><td>0%</td><td>0%</td></tr><tr><td>Aug</td><td>-1%</td><td>-1%</td><td>-1%</td></tr><tr><td>Sep</td><td>-2%</td><td>-1%</td><td>-2%</td></tr></table>		Wet	Dry	Avg	May	0%	-3%	-1%	Jun	0%	-1%	0%	Jul	0%	0%	0%	Aug	-1%	-1%	-1%	Sep	-2%	-1%	-2%	<table><tr><th></th><th>Wet</th><th>Dry</th><th>Avg</th></tr><tr><td>May</td><td>0%</td><td>-3%</td><td>-1%</td></tr><tr><td>Jun</td><td>0%</td><td>-4%</td><td>0%</td></tr><tr><td>Jul</td><td>0%</td><td>-4%</td><td>-1%</td></tr><tr><td>Aug</td><td>-1%</td><td>-5%</td><td>-2%</td></tr><tr><td>Sep</td><td>-2%</td><td>-7%</td><td>-3%</td></tr></table>		Wet	Dry	Avg	May	0%	-3%	-1%	Jun	0%	-4%	0%	Jul	0%	-4%	-1%	Aug	-1%	-5%	-2%	Sep	-2%	-7%	-3%
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Winter food – zooplankton is primary food – mostly produced the spring before. Spring – dipterans – primary food Summer – low nutrient so turn to terrestrials, 2 fly, 2 don't (leafhoppers, coleopterans beetles). Flies, bees, wasps, still able to get to water surface. Fall – switch back to aquatic insects and zooplankton. Euphotic zone by month: Jun: 30 feet Jul: 50 feet Aug: 70 feet Sep: 80 feet To calculate change in euphotic zone, convert elevation NAA to volume; then elevation 30 feet lower to volume and subtract to estimate euphotic zone for NAA. Do the same for MO1 through 4 and compare.	–	–	–	–																																																																																																		
Follow-up quantification of surface area available for terrestrial insect feeding. Elevations at the	–	NAA: Hungry Horse Surface Area (Acres)	<table><tr><th>MO1</th><th></th><th></th><th></th></tr><tr><td>Month</td><td>Wet</td><td>Dry</td><td>Avg</td></tr><tr><td>Oct</td><td>-2%</td><td>-3%</td><td>-3%</td></tr></table>	MO1				Month	Wet	Dry	Avg	Oct	-2%	-3%	-3%	<table><tr><th>MO2</th><th></th><th></th><th></th></tr><tr><td>Mth</td><td>Wet</td><td>Dry</td><td>Avg</td></tr><tr><td>Oct</td><td>2%</td><td>3%</td><td>3%</td></tr></table>	MO2				Mth	Wet	Dry	Avg	Oct	2%	3%	3%	<table><tr><th>MO3</th><th></th><th></th><th></th></tr><tr><td>Mth</td><td>Wet</td><td>Dry</td><td>Avg</td></tr><tr><td>Oct</td><td>-2%</td><td>-4%</td><td>-3%</td></tr></table>	MO3				Mth	Wet	Dry	Avg	Oct	-2%	-4%	-3%	<table><tr><th>MO4</th><th></th><th></th><th></th></tr><tr><td>Mth</td><td>Wet</td><td>Dry</td><td>Avg</td></tr><tr><td>Oct</td><td>0%</td><td>0%</td><td>0%</td></tr></table>	MO4				Mth	Wet	Dry	Avg	Oct	0%	0%	0%	Follow-up quantification of food production analyses. Notes of 7/2/19.																																															
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end of each month (from the elevation comparison tool) in wet, dry, and average year types were converted to surface acres using conversion tables provided by MFWP.		Month	Wet	Dry	Aug	Nov	-3%	-3%	-4%	Nov	3%	3%	4%	Nov	-3%	-4%	-4%	Nov	0%	0%	0%	Three lobes of reservoir different shapes. Emery (Main lobe, towards dam) Murray Sulivan Not able to do separate surface area analyses to further inform insect production in the time available.			
		Oct	22345	22345	22448	Dec	-4%	-2%	-4%	Dec	4%	2%	4%	Dec	-4%	-2%	-4%	Dec	0%	0%	0%				
		Nov	22038	21833	22345	Jan	-2%	-2%	-3%	Jan	-2%	2%	-1%	Jan	1%	-2%	1%	Jan	0%	0%	0%				
		Dec	21935	21221	22038	Feb	-1%	-3%	-3%	Feb	-6%	3%	-2%	Feb	7%	-3%	2%	Feb	0%	0%	0%				
		Jan	21119	20611	21527	Mar	0%	-3%	-2%	Mar	-7%	3%	-2%	Mar	7%	-3%	2%	Mar	0%	0%	0%				
		Feb	19913	20113	20812	Apr	0%	-3%	-2%	Apr	-4%	4%	-1%	Apr	4%	-4%	1%	Apr	0%	0%	0%				
		Mar	17280	19814	20212	May	0%	-2%	-1%	May	-2%	-1%	0%	May	3%	1%	0%	May	-1%	0%	0%				
		Apr	152123	20511	19913	Jun	0%	0%	0%	Jun	0%	-1%	0%	Jun	0%	0%	0%	Jun	0%	-3%	0%				
		May	18754	22652	21731	Jul	0%	0%	0%	Jul	0%	0%	0%	Jul	0%	0%	0%	Jul	0%	-3%	0%				
		Jun	23072	23602	23602	Aug	-1%	0%	-1%	Aug	1%	1%	1%	Aug	-1%	-1%	-1%	Aug	0%	-4%	-1%				
		Jul	23707	23178	23602	Sep	-2%	-1%	-2%	Sep	2%	2%	2%	Sep	-2%	-2%	-2%	Sep	0%	-4%	0%				
		Aug	23284	22448	23178	-				-				-				-							
		Sep	22755	21731	22755																				
Increased outflows can increase the entrainment loss of zooplankton. Changes in lake levels and selective withdrawal locations could exacerbate this issue.	Hungry Horse outflows (mean monthly outflows) and qualitative assessment of stratification and elevation changes.	Average Monthly Outflow (25%, 50%, 75%)				Percent change from change doc. (25%, Median, 75%)				Increased outflows in Jan/Feb over 100% increase in median years. 6,000 to 6,100 in MO1				Oct: -5%, -7%, -12% Nov: -2%,-6%,-16% Dec: -6%, -6%, -16% Jan: -12%, -3%, -8% Feb: -23%, -5%, -6% Mar: -15%, -7%, -5% Apr: -4%, -19%, -20% May: -4%, -8%, -12% Jun: -7%, -8%, -11% Jul: +2%, +1%, +9% Aug: Higher 17%, 21%, 18% Sep: Higher 17%, 21%, 19% Similar to MO1				Change from NAA (25%, 50%, 75%) Oct: -4%, -6%, -10% Nov: -1%,-6%,-14% Dec: -5%, -6%, -12% Jan: -12%, -3%, -7% Feb: -22%, -4%, -5% Mar: -14%, -7%, -4% Apr: -5%, -15%, -18% May: -4%, -6%, -8% Jun: -3%, -5%, -6% Jul: Higher +8%, +11%, +17% Aug: Higher 36%, 37%, 35% Sep: Higher 36%, 37%, 35% October through June is similar to MO1 and MO3. July, Aug, and Sept much higher; expect entrainment of zooplankton and reduced food for fish, similar to MO1 but in higher magnitude.				NA			
		Oct: 2242, 1934, 1386				Oct: Same as NAA																			
		Nov: 2353, 1979, 1426				Nov: -1%, -6%, -14%				Oct: -5%, -6%, -10%															
		Dec: 2731, 2425, 2134				Dec: -4%, -6%, -10%				Nov: -1%, -2%, 0%															
		Jan: 3110, 2625, 2340				Jan: -12%, -3%, -7%				Dec: 0%, -1%, -1%															
		Feb: 3997, 2745, 2418				Feb: -21%, --4%, -5%				Jan Higher: 179%, 108%, 15%															
		Mar: 5651, 2715, 2249				Mar: -12%, -6%, -3%				Feb Higher: 50%, 2%, -1%															
		Apr: 8142, 5433, 3147				Apr: -5%, -13%, -17%				Mar: -8%, -8%, -8%															
		May: 7017, 5655, 4062				May: -4%, -6%, -9%				Apr: -17%, -17%, -12%															
		Jun: 6051, 4257, 3160				Jun: -7%, -8%, -11%				May: -1%, -2%, +3%															
		Jul: 4170, 3400, 2592				Jul: +1%, +1%, +9%				Jun: -25%, -37%, -50%															
		Aug: 3083, 2680, 2389				Aug Higher: 17%, 21%, 19%				Jul: -3%, -3%, 10%															
		Sep: 3082, 2680, 2393				Sep Higher: 17%, 21%, 18%				Aug Higher: 17%, 21%, 19%															
		Zooplankton would continue to be entrained into the South Fork Flathead River from Hungry Horse Reservoir. The zooplankton enhances food supply in the South Fork Flathead River and along the near bank of the Flathead River, but decreases food supply for fish in Hungry Horse Reservoir. Zooplankton entrainment moves through South Fork Flathead, also stays along one bank, mixes about Teakettle.				Entrainment/outflow decreased in winter months, and typically spread equally, so correlate directly to outflows. In summer months, zooplankton more susceptible to entrainment because they are concentrated at withdrawal location, and more outflow would result in increased entrainment of zooplankton. Aug and Sep, increased entrainment reduces food source for bull trout prey base and juveniles while they are staging for migration. Increased zooplankton entrainment could help South Fork Flathead. Mitigation: restore operation of slide gates; allows to				Sep Higher: 17%, 21%, 18%				Sep Higher: 17%, 21%, 18%											
										Note: these are incorrect!															
								Zooplankton would be decreased in correlation to outflow changes in winter months and in Aug/Sept. All are important months for bull trout FMO. Expect decreased food supply for fish; roughly double the amount of zooplankton lost to entrainment. Zooplankton are winter food supply for fish. Bull trout are piscivorous, juveniles directly affected by zoo loss; adult bull trout indirectly due to reduction in food supply for prey species. Entrainment would be less in Mar-June.																	

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			mix water both warmer and colder of target temp and mix them rather than taking directly from the target temp where the plankton are concentrated. Temperature gauge array on face of the dam to determine where target temperature is. NOTE: Zooplankton entrainment study - Cavigle et al., 1998 (Pam has)				
Increased outflows can increase entrainment of bull trout and other fish.	Hungry Horse outflows, mean monthly in all months, 25%, 50%, and 75% exceedances. See outflow comparison to visually compare alternatives.	See above. Some level of bull trout entrainment would probably occur, though it is not known how much or from which outlets. Although there may be entrainment occurring, no data or studies to determine how much or at what flows/outlets. It is not known to affect the South Fork populations in the reservoir and tributaries. Possible scenarios - concentration of food sources near the outlet could make them more susceptible. Shape of dam - most species immersal (littoral) and the intakes are out to the sides. If any alternatives alter the thermal structure so it concentrates bull trout near the outlets it could be an issue. Vertical sonar indicated no targets near outlets for selective withdrawal. Bull trout and Northern pikeminnow were only species found at great depth (>100 feet approximately), so more susceptible to entrainment. When isothermal (turns over) fish spread out, selective withdrawal only when stratified. When bull trout go deep, they could be more susceptible to entrainment during stratification.	See zooplankton entrainment relationship above. Increased outflows July, Aug, Sep. Entrainment expected to increase with higher outflows. Water withdrawal - June - by surface (20 feet or so), then gradually deeper through Jul. Aug/Sept start to go deeper to get target temps, fish are in the strata where being outflows. Bull trout and pikeminnow more susceptible at late summer, when outflows increase by about 20%. Entrainment rates not known, but would increase by about 20% or more.	See outflows from Hungry Horse. Expect higher entrainment of fish in winter months. Bull trout are more likely to be in the reservoir in these months, but may be spread throughout the reservoir rather than concentrated at the depths near the outlets.	Same as MO1.	See outflows from South Fork Flathead section. 37% higher in Aug/Sep. Concentration of littoral zone closer to penstocks would increase entrainment risk. 37% more outflow would increase entrainment. Relationship would be more than direct correlation because of increased risk. Bull trout and pikeminnow more susceptible because they are found deeper where withdrawals would be from.	Westslope cutthroat trout – high densities below Hungry Horse. Could stray to somewhere else to spawn or lost from population. High susceptibility to entrainment because taking water from zone where they occupy. Other native fish – suckers, pikeminnow higher subject to entrainment because they hang out by the face of the dam. Pikeminnow and bull trout occupy deep strata. Suckers are also right by surface. Water withdrawal – Jun – by surface (20 feet or so), then gradually deeper through Jul. Aug/Sep start to go deeper to get target temperatures, fish are in the strata where being outflows. Mitigation – entrainment studies to determine if an issue, mitigate commensurate with effect.
Elevation can influence exposure to angling exploitation and predation for bull trout where tributaries enter the reservoir.	Hungry Horse elevation Bull trout: Jul to Oct. Westslope cutthroat trout and other spring spawn: Apr to Jun.	If full in summer, not as much issue, with current draft in summer increases exposure in bays where tributaries enter reservoir. Years with 20-foot drafts and don't reach full (overestimate inflow forecast) is when this is an issue.	Visually compared: Wet, dry, ave all similar pattern. Use median end of month elevations. Jul: Aug: 3552 (-3 feet) Sep: 3546 (-4 feet)	MO2 similar to NAA in Jul/Aug. When bull trout staging to migrate upstream to tributaries, the elevation would be similar to NAA.	–	Dry years, Sep elevation 3429.5.	Varial zone in deeper drafts topography unknown. Delta aggradation likely has built up deltas. Potential mitigation – research bathymetry of tributary zones; identify potential channel

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Affected Environment Important Relationships / Criteria	Environmental Consequences Metric	Environmental Consequences NAA	Environmental Consequences MO1	Environmental Consequences MO2	Environmental Consequences MO3	Environmental Consequences MO4	Notes
			More exposure to predation/angling in Aug for upstream migrations. In late Sept through Oct as adults migrate back into reservoir there would be more exposure. Likely moving at night. More varial zone to pass through to get to reservoir pool. Tributary delta underwater now is not known, but if has sedimented up there could be full blockages of tributaries; preventing both ingress and egress.				reconstruction and cover. (See Deadwood examples for lessons learned.) Large woody debris in bays to provide cover. Modernize reservoir model HRMOD with updated bathymetry, translate into modern code – to evaluate specifically where effects happen, helps fine-tune operations decisions.
Access to spawning areas can be affected by reservoir levels. At NAA elevations, bull trout (and other species) typically have access. At lower elevations access to spawning tributaries could become problematic. NOTE: more applicable to westslope cutthroat trout.	Median end of month elevation Bull trout: Aug to Sep. Westslope cutthroat trout and others: Apr to Jun.	Median End of Month Elevation: Aug: 3555 Sep: 3550 Apr: 3520 May: 3539 Jun: 3558 Changes in reservoir operations implemented in 2009 have reduced water level fluctuation during the summer and fall, which overlaps with the primary period when bull trout are migrating to spawning and overwintering habitats in tributaries. (2016 BA). The NAA would continue to provide access to spawning tributaries.	Aug: 3552 (-3 feet) Sep: 3546 (-4 feet) Apr: 3515 (-5 feet) May: 3536 (-3 feet) Jun: 3558 (similar to NAA) See above notes. Westslope cutthroat trout: Spawning, entering in April, and leaving through late June. Lower elevations through Apr and May, by Jun 1 back up to near NAA. More exposure in bays to predation/angling. Tributaries on descending limb on June as westslope cutthroat trout coming	Aug: 3555 (0) Sep: 3550 (0) Apr: 3515 (-5 feet) May: 3536 (-3 feet) Jun: 3557 (-1 foot) No effect.	Aug: 3552 (-3 feet) Sep: 3546 (-4 feet) Apr: 3515 (-5 feet) May: 3536 (-3 feet) Jun: 3558 (similar to NAA) All same as MO1.	Aug: 3551 (-4 feet) Sep: 3545 (-5 feet) Apr: 3515 (-5 feet) May: 3535 (-4 feet) Jun: 3556 (-2 feet)	Hungry Horse mitigation and implementation plans. Brian provide e-copy. Mitigation: passage improvements. Example: McInernie culver, others? Look for undersized culverts and improve them. Possibly replace with arch culverts or bridges. Continue to restore and protect genetic diversity in native spp. Through funding continued conservation aquaculture, etc. Sekokini springs facility (genetic conservation facility - current mitigation for HH) Mitigate for losses to westslope cutthroat trout. (hybridization, etc., issues, or just population losses).
Water temperatures affect habitat suitability. Surface elevation affects thermal structure of pool; fish seek preferred temperatures; volume of temperature range affects amount of habitat available.	Hungry Horse elevations; mid-Jun through Sep, qualitative from water quality team.	Water temperatures in reservoir are appropriate for bull trout. Spring food source mainly affected (in summer, switch to terrestrials).	Similar to NAA (from water quality presentation).	No change expected.	No change.	No change from NAA.	NA.

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Affected Environment Important Relationships / Criteria	Environmental Consequences Metric	Environmental Consequences NAA	Environmental Consequences MO1	Environmental Consequences MO2	Environmental Consequences MO3	Environmental Consequences MO4	Notes
South Fork Flathead River below Hungry Horse							
—	—	Potentially migratory/overwintering habitat only/Transitional habitat only. No spawning within the mainstem South Fork below Hungry Horse and no spawning tributaries in that reach. CH is not designated below the dam (see CH Unit 31). With selective withdrawal temps that are more conducive; we see some bull trout juveniles and adults in river. Don't know if entrained from Hungry Horse or from main Flathead. Probably Flathead - when stop selective withdrawal most move back out to the main Flathead.	—	—	—	—	—
Water volume/flow affects available habitat? Minimum in-stream flows 400 cfs to 900 cfs on sliding scale based on water availability. Most critical to meet South Fork minimums during spring runoff (otherwise are met automatically to provide to Columbia Falls).	Flows – water volume during late summer.	See outflow comparison. Bull trout would likely use the river below Hungry Horse during what months? Oct through Jul? Year-round? They are just visitors here. Typically release > minimum in South Fork Flathead to meet Columbia Falls minimums. Exception in flood emergency, can reduce to spin/no-load flows of 1 turbine.	Lower flows in Apr-Jun in average years Lower flows Feb-Apr in wet years Lower flows in Apr in dry years 500 (11%) cfs higher than NAA in Jun to Aug MO1: 4992 NAA: 4482 Higher flows in the summer would be beneficial, more wetted perimeter and invert production, if the flows are stable. Would be keeping shoreline wet longer that was already wet; good for invert production. However, would likely reduce availability of suitable habitat for bull trout due to increased velocities. Lower outflows from Hungry Horse in Apr to Jun result in very minimal change in Flathead River, because still release to meet minimum in-stream flows.	Dry - much higher in May, much lower in Jun, slightly lower through Jul to Sep. (900 cfs minimum flows through much of Jun. Ave - much lower early May, higher late May, lower Jun Wet - Much higher Jan to Feb, much lower early May, higher late May, lower Jun Jan flows: More fluctuations between high flows and low flows would disrupt the production of aquatic inverts every time flows are increased for a time and then dropped again. Drops in Jan to Feb, Apr to May, May to Jun, Jun to Jul. Much higher flows in late May would likely push out juvenile forage fish, and result in less habitat available for bull trout and westslope cutthroat trout.	Similar to MO1.	Dry – Jul drops steeply from NAA, Jul-Sep higher Ave – Jul-Sep about 500 cfs higher than NAA. Wet – same as MO1, lower Feb-Apr, higher Jul-Sep Jul +11%, +400 cfs Aug +37%, +1000 cfs Sep +37%, +1000 cfs Wet/Ave similar to MO1, slightly higher magnitude. Dry year - steep dip in mid-Jun would "reset" the bio productivity in Jun as the South Fork Flathead River would drop. It would take until (60 to 90 days) Aug to reset the biota and recover to be food source for fish. By then, the time period for fish growth would be almost over. In summer months, South Fork effects: departs further from normative flows, reduces amount of low velocity habitat available. IFIM shows reduction of habitat due to velocity. Suckers - juveniles in August, flushed downstream, reduce bull trout food source. Summer in riffles is young-of-year or yearling	Mitigation: Didymo research - reducing didymo, it displaces aquatic inverts. Reducing would increase food supply for fish. Create back-channel habitat for juvenile bull trout, create trout rearing habitat. Creston National Fish Hatchery - funding for bull trout conservation (Hungry Horse mitigation in NAA?). Public interest in species - opportunities to increase awareness and allow bull trout harvestable populations. Redirect harvest - grow and take fisheries for cutthroat in small lakes in area. Mitigation - smooth out the drop in June, fail to refill but would be better to not drop flows. Avoid short-term flow reductions to avoid dewatering benthos.

Affected Environment Important Relationships / Criteria	Environmental Consequences Metric	Environmental Consequences NAA	Environmental Consequences MO1	Environmental Consequences MO2	Environmental Consequences MO3	Environmental Consequences MO4	Notes
						mountain whitefish; these could get flushed out. Riffle habitat is important.	
Within day fluctuations in the river and day to day. Short-term flow reduction to productivity. Takes time after coming back up for productivity to return.	Review measures in alternatives to detect if any increase in fluctuations would be expected. Daily discharge data, Jun to Sep.	Flow gauge data; and examine measures. Food resources are still impacted by day to day and within-day fluctuations.	Similar to NAA.	Ramping rates for safety would remove ramping rate restrictions put in place to protect fish. Treaty has good qualitative discussion of ramping effects. Additional fluctuations would decrease food production.	Same as MO2.	Same as NAA.	–
Water temperatures affect habitat suitability and competition with lake trout and northern pm. Selective withdrawal restores temperature regime to near-natural seasonal temperatures. This benefits growth potential and food production. Designed to operate at a specific range of elevations.	See above. Ability to operate selective withdrawal.	Not readily available - but through agreements water temperature is kept between 10°C and 15°C during SWS operations - suitable for BT and other native fish and similar to SF and NF flows. Difficult to meet temp targets until mid-summer in high flow years. Low flow years easier to meet temperature targets sooner. Typically release > minimum in South Fork Flathead to meet Columbia Falls minimums. Exception in flood emergency, can reduce to spin/no-load flows of 1 turbine.	From water quality presentation – all elevations within ability to operate. No change to temperature expected. Same as NAA.	Increased flows in Jan. Likely to warm the South Fork in the winter.	Same as MO1.	No change.	Design specifications for selective withdrawal range of operations. Dennis Christenson publications. All alternatives will continue to use the SWS, which can only operate until late fall/early winter. Lake trout used to inhabit South Fork Flathead, when water temperature reaches 14°C the lake trout move back out. Natural temperature regime is conducive to native fish.
Flathead River (South Fork Confluence to Flathead Lake)							
–	–	From South Fork confluence to mouth is 47 miles of habitat, but up to about 20 miles is controlled by lake effect (Flathead Lake). Relationships below can influence Flathead River conditions that could affect the balance of native/non-native spp. Conditions for invasive non-native fish; they are more tolerant of degraded water quality than bull trout. Could be indirect effect if skews conditions towards non-natives.	–	–	–	–	–

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Flows in summer affect availability of suitable habitat (IFIM). Higher than normative summer flows can create velocities too high for suitable habitat.	Hungry Horse outflows and Columbia Falls elevations.	Summer flow augmentation creates higher summer flows leads to reduction in juvenile and adult bull trout habitat (also westslope cutthroat trout). Winter: bull trout in deep at day, then into shallows at night to feed. Westslope cutthroat trout don't do diel movement likely bull trout do. Move with insect hatches.	Similar to NAA (just slightly higher in Aug, otherwise very similar).	Same as NAA.	Same as MO1.	–	–
Winter flows currently higher than natural; higher winter flows affect reestablishment of riparian vegetation leads to less shoreline habitat for all fish. Winter flows – ice formation...lower river freezes now. 39°F to 41°F water releases from Hungry Horse. Under-ice refugia for bull trout.	Hungry Horse outflows.	Winter flows about 2,100 cfs to 2,700 cfs.	Wet years, lower flows in Feb.	Higher winter flows. High winter flows could limit cottonwood regeneration if Jan flows scour, but observed that the Jan increase would be below the elevation where cottonwoods would be establishing.	–	–	–
Decreased spring runoff peak leads to less frequent channel maintenance flows from South Fork Flathead. Also important for riparian recruitment. Cottonwood recruitment in lake-influenced portion of the river.	Hungry Horse outflows	See flow comparison to determine need for additional analyses. Peak about 30,250. Woody material and gravel recruitment would continue to be impeded by Hungry Horse Dam; downstream effects - minor effect to bull trout but maybe for other resident fish. Interstitial spaces for inverts (benthic production)	Same as NAA.	Slightly higher flow peak in May; at Columbia Falls - 32,954 peak MO2, compared to 30,248 peak in NAA (about 2700 cfs or 8% higher) Higher than NAA peak flows could provide better channel maintenance.	–	–	–
Temperature effects. Temperature benefits of selective withdrawal in summer, but not in winter when South Fork contribution to flow is disproportionately high.	Hungry Horse outflows	See outflow comparison. Current contribution of South Fork flows results in some warming in winter.	Slightly lower outflows in winter, with less temperature influence.	Increased South Fork flows contribution in winter could warm the Flathead River. Predominant trout is rainbow hybrid. Could increase productivity and metabolism of resident fish disproportionately to migratory native bull trout and westslope cutthroat trout. Under NAA, South Fork is about 60% of flow, and 8-10°F Flathead flows. MO2 would increase South Fork contribution; warming the Flathead River. Example: stoneflies emerge too soon when freezing out.	–	–	–

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TDG – High TDG levels can cause health effects to fish.	–	TDG at South Fork Flathead typically tops out at 117%, downstream stays near bank, and mixes about Teakettle Bridge. Affects habitat suitability for bull trout. Spring spill would continue, continued TDG elevated to up to about 117%.	No change. Same as NAA.	Reduced TDG. See water quality presentation. No change from NAA to fish.	–	–	–
Potential increase of effect of lake erosion at top of Flathead Lake could be affected by Hungry Horse outflows. Negligible water quality effects, but look at outflows changes to water quality.	Flathead River 96.816, 111.984, and 120.403.	See hydrographs. Upper area of lake where river meets. Bull trout, subadults and adults hang out there. Northern pike and bass. Sloughs and lower river could be transitory for lake trout.	Same as NAA.	Jan timing would not affect erosion. As modeled, no effects. Could potentially see changes in lake elevations if SKQ operations don't pass through flows as modeled.	–	–	–
Flathead Lake/Lower Flathead River							
–	–	Live in Flathead Lake, migrate to tributaries of North Fork and Middle Fork Flathead "and occasionally in SF". Early summer from lake into river staging areas; into spawning tributaries in Aug, spawn Sep, then back to Flathead Lake (fluvial), or Flathead River (adfluvial). 4 to 5 years in lake, stage and spawn in tributaries to Flathead River upstream of lake, most go back to lake and some in river. Mostly 3- to 4-year-olds.	–	–	–	–	–
Operations of SKQ could change in relation to different inflow regimes. Changes in winter flows could affect rearing fish in lower Flathead River below SKQ.	SKQ outflows	See summary hydrograph. Stable winter base flows, about 7,700 cfs in Jan. Under NAA, spring flows are greatly diminished. Cumulative effects: Up to 90K out of Hungry Horse for water supply measure may decrease diversions in tributary streams. Providing this water will help restore more normative flows in those tributaries for huge benefits in tributaries. CSKT water compact. Not a direct or indirect effect. Check with Jen for water supply language. Note: Pike currently are near atretic when lake levels come up far enough for them to get into	Not biologically noticeable, happens in high flows. Potential - smallmouth bass spawning time. Modeled that all inflows passed through in outflows, but in real operations some inflows could be captured and released differently. If operated as modeled, no effect.	Higher late May, lower Jun Higher Jan 3400 cfs higher at base flow conditions.) 10%, 9% lower outflows (SKQ) in May and Jun. Increased Jan flows: Stress from flow changes would cause fish movement, they would move into newly flooded shallows that would not have food available. Negatively affect fish, primarily juveniles. Need appropriate ramping rates on ramping down. When flows come back to base in Feb, not as much of an effect, but stressed from displacement. Fish in lower Flathead River, flows reduced by 9% to 10% likely not	Same as MO1.	Aug:+12% Sept: +7% SKQ operations: would ops change with increased inflows in summer. Assume no change in operations. May actually mimic more natural hydrograph in MO4 (higher summer, lower winter).	Hungry Horse: Assume same operations of SKQ, if more summer inflow causes them to change operations with more water for power generation it could cause some changes we'd need to look at. Check also - flood stage change at Columbia Falls gauge. Assumes ramping rates at SKQ still apply. Likely no effects to thermodynamics in Flathead Lake, volume is large, and time of year (cold water to cold water). Likely no effect to shoreline erosion, water. Potential effect to riparian regeneration? If flows up for a month, could get hanging ice,

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		bays and spawn. Any delay in lake refill could reduce spawning success for pike.		biologically noticeable. More dominated by non-natives, but bull trout and westslope cutthroat trout are there.			used to do peaking; the up and down freezing over shorter period caused ice stacking that damaged riparian vegetation. Not likely in this case. Cottonwood regeneration issue - already happens under NAA. SKQ already operated higher in winter, additional flow could exacerbate the issue. (note for cumulative effects). Already altered hydrograph, native fish likely cue on the tributary hydrograph (not affected by the alternative).
Entrainment through SKQ Dam? Factors affecting? Effect to Flathead Lake populations? No data on entrainment, but assume fairly insignificant.	Flows/discharge	Bull trout in Flathead Lake are likely entrained through Kerr Dam or migrate up from Clark Fork. Warmest water in lake in summer goes in, warmest water out SKQ, but no changes to elevations or SKQ operations; should not change. Could be mixed age populations in winter. USFWS concerns about irrigation pump in forebay of dam.	Slightly less outflow in May/Jun. Likely no fish in area of dam at this time. No effect.	Higher late May, lower Jun Higher Jan (3400 cfs higher in Jan) Fish would be in the area near the dam in Jan. Temps favorable. Entrainment would expect to increase with higher outflows. If entrained, lost from population and would not be a part of any other population. Lost from Middle Fork and North Fork Flathead (tributary populations). Lower outflows in May/Jun would be when bull trout and westslope cutthroat trout are not in the area of the dam.	Same as MO1.	Same as MO1. Potentially increased entrainment of temp tolerant fish (smallmouth bass, pike, etc.) Only 14.5 kcfs is turbine, the rest in spill. Expect increased spill, surface. May further increase habitat for non-native fish.	Bull trout not there. Bottom lobe near the outlet is shallow, keeps too warm in summer and fall, but in Jan they could get down towards the dam.
Mysis – supports lake trout populations. Do not expect important relationship here, but think through Hungry Horse outflows.	Hungry Horse outflows	NA	NA	NA	NA	NA	NOTE: No change in alternatives. Noted here that the team considered it.
Temperature in Flathead Lake? Do not expect temperature changes due to operations. Add basic temperature baseline info.	Inflow volume, temperature from water quality.	No temperature of North and Middle Fork, have selective withdrawal on South Fork, so only temperature difference would come from volume changes. Expect very minor. Diluted by Stillwater, Swan, etc. Temps in Flathead Lake support bull trout FMO.	Same as NAA.	Same as NAA.	Same as NAA.	Same as NAA.	NA

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Clark Fork River							
—	—	Fragmentation by Clark Fork hydro dams results in isolated populations and reservoir environments favor non-native species. Less than 100 spawning adult population in Jocko. Mission Creek used as migratory corridor. Bull trout passage improvements at Cabinet Gorge are underway (currently trap and haul, planned passage), and there is passage at Thompson Falls.	—	—	—	—	—
Flows can affect spawning habitat for smallmouth and pike. Increased flows in summer could increase spawning habitat. Lower summer flows decrease spawning habitat.	Flathead River 11.506, any Clark Fork near Plains.	Higher summer flows could increase spawning habitat for non-natives. Below Thompson Falls in Lake Pend Oreille influenced.	Same as NAA.	See above for changes. Higher Jan, lower May/Jun. Likely no effect to non-native predators.	Same as NAA.	Higher summer flows could increase pike, smallmouth habitat. Favor non-native fish.	NA
Flows affect downstream flushing of northern pike and walleye from Noxon and Cabinet Gorge reservoirs.	Clark Fork 31.41	NAA would continue some level of flushing pike and walleye downstream. Analyze any increases in flow.	Similar to NAA	Slightly lower May/Jun. Likely no effects from higher winter flows; potentially slightly less flushing in spring flows if lower May/June. Fry and Juveniles get flushed with spring pulses. Cabinet Gorge and Noxon both ice over, wouldn't expect any flushing.	Similar to NAA.	Aug +12% Sept +7% Any increase could pass more fish, expect some increase in entrainment. The bigger issue is big spring flows when they've seen increase in pike - juveniles get flushed. This increase in later summer flows likely not a big increase in juvenile flushing.	N/A
Effects to trap and transport at Cabinet Gorge.	Clark Fork 31.41	See Summary hydrograph at Clark Fork 31.41	Slight difference in Dec in 1%, otherwise similar to NAA.	Winter Flow changes attenuated to less than 2 inches at this gauge.	Similar to NAA.	0.3 to 0.5 feet lower than NAA in Mar/Apr. Water surface elevations increases in Aug, Sep. About 4 feet higher. Lower elevations in Mar/Apr reduce pike spawning success in lower Flathead.	N/A

Table 3-70. Flathead/Clark Fork Qualitative Effects Analysis Matrix Part 2

Affected Environment Important Relationships/Criteria	Affected Environment Metric	Environmental Consequences H&H and Water Quality Outputs	Environmental Consequences Effects to Resource NAA	Environmental Consequences Notes	Citations
Westslope Cutthroat Trout					
Hungry Horse Reservoir					
Tributary Access/Varial Zone	Water surface elevation at forebay.	Water surface elevation during winter/spring? Not sure when they move out of the reservoir.	–	No issues for bull trout same for westslope cutthroat trout? “The South Fork represents the largest connected population of migratory, genetically unaltered westslope cutthroat trout left in the United States.” Since they move out, probably during refill operations, I would think reservoir elevations would be okay.	file:///C:/Users/pdruliner/Downloads/02_SouthForkFlatheadRiver.pdf
Entrainment	Unknown	Unknown	–	Probably not an issue given the statement above.	–
Competition	Chance of full pool lake elevation in Jul.	Full pool is 3560 Hungry Horse elevation duration monthly For Jul 50% = 3559.17 60% = 3558.59 70% = 3557.36 80% = 3557.70 90% = 3552.97	Current management is to try to reach full pool (Elevation 3560?) by early summer to provide adequate primary productivity. There would be a 50% chance of elevations being within about a foot of reaching full pool and remaining there for the month of July, a 60% chance of exceeding 3558.7 feet, at 70% chance of exceeding 3557.4, an 80% chance of exceeding 3555.7 feet and a 90% chance of exceeding 3553 feet. This would continue to provide an adequate food source for winter supply of zooplankton that fuels the food web.	Our operations are not going to influence competition for NAA.	–
Spawning Areas	–	–	–	No spawning in reservoir.	–
Migration/Barriers	–	–	–	Other than the dam, likely none.	–
Water Temperature	–	–	–	No known issues.	–
Food/Productivity of Reservoir	–	–	–	Lake bull trout, probably fine.	–
Elevation can influence exposure to angling exploitation and predation by bull trout on westslope cutthroat trout. If full in summer, not as much issue with current draft in summer increases exposure in bays where tributaries enter reservoir.	Reservoir draft in spring; change in elevation from full pool.	About 10-foot drop (3560 to 3550). Jul 1: 3560 feet Sep 30: 3540 feet	–	Years with 20-foot drafts and do not reach full (overestimate inflow forecast) is when this is an issue.	–
Access to spawning areas can be affected by spring reservoir levels. At elevation XX (Brian provide), access to spawning tributaries is cut off.	Percent exceedance Hungry Horse elevation at or above XX during mid-Apr to end of Jun.	–	Lake levels would continue to provide access to spawning tributaries.	Spawn in tributaries above Hungry Horse and the South Fork Flathead upstream of reservoir. Tributaries have been “fixed,” with culvert replacements or baffles: improved passage. Westslope cutthroat trout spawn in numerous tributaries above Hungry Horse Reservoir.	–
Water temperatures affect habitat suitability – surface elevation affects thermal structure of pool; fish seek preferred temperatures; volume of	Hungry Horse elevations; mid Jun through Sep.	–	–	Applies the same as bull trout.	–

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temperature range affects amount of habitat available.					
Loss due to entrainment? Could be increased entrainment if outflow is increased.	Outflows	–	NAA: Entrainment is not a problem and not expected to be (see notes)	Although there may be entrainment occurring, no data or studies to determine how much or at what flows/outlets. It is not known to affect the South Fork populations in the reservoir and tributaries. Possible scenarios – concentration of food sources near the outlet could make them more susceptible. Shape of dam – most species immersal (littoral) and the intakes are out to the sides. If any alternatives alter the thermal structure so it concentrates westslope cutthroat trout near the outlets, it could be an issue. Vertical sonar indicated no targets near outlets for selective withdrawal. When entrainment does occur, it is relative to discharge volume and depth of withdrawal. Westslope cutthroat trout did not go to depth like bull trout (Montana Fish, Wildlife, and Parks, unpublished data), so not as susceptible to predation.	Cavigli reports for zooplankton entrainment.
Zooplankton entrainment was considered, not an issue. Selective withdrawal can increase zooplankton entrainment. Changes in lake levels could exacerbate this issue.	–	–	–	Zooplankton cells become denser with less volume, so less volume could result in increased entrainment of zooplankton and reduced food supply in Hungry Horse.	See BPA reports.
Maximum elevation draft in one year affects insect larvae production the following year.	Maximum drawdown – typically in mid-Apr.	Median 3520 feet.	–	The deeper the maximum drawdown, the worse the spring food supply from benthic productivity.	–
Maximum lake elevation.	Maximum lake elevation.	–	Current management try to reach full pool.	Biologically productive warm months, want the reservoir as full as possible. Gives large body of warm euphotic zone for primary production. Zooplankton production (for winter food), summer food is terrestrial insect.	–
Shape of refill/drawdown. Gradual slopes maximize productivity (even if fail to fill) compared to fast refill or drawdown just to “touch” full.	Rate of refill to full pool, duration at/near full before drawdown. Duration at maximum elevation.	–	–	Fast filling/drawdown retards productivity. Even at full pool, the substrate is wet but needs to wet 5 to 7 weeks in order to be productive – populate with plants, then inverts move in. If dewater before this process completes, there is no benefit to production.	–
South Fork below Hungry Horse					
Tributary access/varial zone/for spawning	Outflow/discharge	H&H winter-summer hydrographs?	Probably little	Is this a known concern from MFWP?	–
Entrainment	–	–	–	Same as bull trout – unknown degree.	–

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Competition	Water temperature	–	–	SWS has positive effect of limiting numbers of lake trout.	–
Migration Barriers	–	–	–	NA?	–
Water temperature	–	–	–	Okay with SWS	–
TDG	–	–	–	–	–
Water Quality/didymo	–	–	–	–	–
Food/Productivity of River	–	–	–	–	–
South Fork Flathead River below Hungry Horse					
–	–	–	–	South Fork Flathead River use by westslope cutthroat trout – densities in South Fork Flathead River are high, most likely come up from Flathead River and return there when temperature control are not operating.	–
Ramping rates affect fish below Hungry Horse and cause westslope cutthroat trout to leave (BPA report, Matt send...2004-05?) displacement by operations with substantial fluctuations is flow. (Not an issue with NAA.)	Hungry Horse outflows; day-to-day fluctuations, percent change from day to day or week to week.	–	NAA operations are designed to avoid this issue.	Show examples of when fluctuations affect fish.	–
Within day fluctuations in the river and day to day. Short-term flow reduction to productivity; takes time after coming back up for productivity to return.	Review measures in alternatives to detect if any increase in fluctuations would be expected. Daily discharge data, Jun to Sep.	Flow gauge data; and examine measures.	Food resources are still impacted by day-to-day and within-day fluctuations.	–	–
Westslope cutthroat trout entrained through Hungry Horse – affected by spill? How? See notes.	We do not know at what flows bull trout are entrained or to what extent – or at what elevation.	–	Any entrainment currently occurring will continue – it has not been identified as a huge issue by USFWS.	Spill occurs in high flow years during spring and early summer. Spillway at Hungry Horse is a glory hole, do not know what is entrained there, or in deep outlet tubes. Spilled water shoots against bedrock, likely no fish survival in entrained in spill.	–
Do we care about didymo? Didymo is present in the South Fork Flathead River, and can cause concerns for native fish by displacing native insects (food source). Community structure – more chironomids. Sloughs, then starts growing again. Can be extensive, but do not know relationships?	–	–	–	Have tried flushing flows. Just flushes the thalweg, not pools or shorelines. Some disturbance has been considered, but not supported by data – just hypotheses.	–
TDG effects. Assume flow > turbine capacity is spill. Likely minimal effect, but increased duration of exposures.	Look at frequency of spill to quality. Detect > TDG potential.	Not readily available, but can use the curves/models developed by Mary Melama and Clyde Lay for the spill test BA and for the Hungry Horse Modernization BA.	See above – elevated above 110 during late spring and early summer during high spill events when spill must occur beyond what the turbines can use. Configurations and operations minimize TDG effects.	Highest TDG has been around 117 (can look at Hungry Horse BA for TDG) – very dependent on air/water temperatures and barometric pressure. Assume any fish in the river is affected downstream to XXX (see Hungry Horse Modernization BA). Downstream gas effects go to Columbia Falls – mixes right above Teakettle Bridge. Have been spilling more with turbines out.	–

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Affected Environment Important Relationships/Criteria	Affected Environment Metric	Environmental Consequences H&H and Water Quality Outputs	Environmental Consequences Effects to Resource NAA	Environmental Consequences Notes	Citations
Selective withdrawal restores temperature regime to near-natural seasonal temps. This benefits growth potential and food production. Designed to operate at a specific range of elevations.	Ability to operate selective withdrawal.	–	–	Lake trout used to inhabit South Fork Flathead, when water temperature reaches 14°C the lake trout move back out. Natural temperature regime conducive to native fish.	Design specifications for selective withdrawal range of operations. Dennis Christenson publications – Brian send.
Water temperatures affect habitat suitability and competition with lake trout and northern pikeminnow.	See above.	Not readily available but, through agreements, water temperature is kept between 10°C and 15°C during SWS operations. Suitable for bull trout and other native fish, and similar to South Fork and North Fork flows.	–	All alternatives will continue to use the SWS, which can only operate until late fall/early winter.	–
Is water volume/flow a concern – available habitat? (See below.)	Flows – water volume during late summer.	–	–	Bull trout would likely use the river below Hungry Horse during what months? Oct through Jul? Year-round? They are just visitors here.	–
Minimum in-stream flows 400 cfs to 900 cfs on sliding scale, based on water availability. Most critical to meet South Fork minimums during spring runoff (otherwise are met automatically to provide to Columbia Falls).	–	–	–	–	–
–	Hungry Horse outflows – ability to meet in-stream flows in spring	–	–	Typically release > minimum in South Fork Flathead to meet Columbia Falls minimum. Exception in flood emergency, can reduce to spin/no-load flows of 1 turbine.	–
Use by Flathead River fish. How affected? Important?	–	–	–	Note: AE says no documentation of spawning in one paragraph, but “occasionally in the South Fork Flathead River” in next paragraph. Help? (Pam: no spawning tributaries below Hungry Horse to the confluence). Workshop – no, no spawning fix in AF.	–

Affected Environment Important Relationships/Criteria	Affected Environment Metric	Environmental Consequences H&H and Water Quality Outputs	Environmental Consequences Effects to Resource NAA	Environmental Consequences Notes	Citations
Native Fish Community					
Hungry Horse Reservoir					
Hungry Horse Reservoir primarily native fish community (westslope cutthroat trout, mountain whitefish, bull trout) isolated by Hungry Horse Dam from non-native species downstream. Only non-native is Arctic grayling.	–	–	–	Notes from Subbasin Assessment (year 2004): Unnaturally high flows during summer and winter negatively impact resident fish. Summer flow augmentation causes reservoirs to be drafted during the biologically productive summer months. This impacts productivity in the reservoirs. Drafting the reservoirs too hard prior to receiving the Jan 1 inflow forecast places the reservoirs at a disadvantage for reservoir refill. This is especially important during less-than-average water years. Flow fluctuations caused by power, flood control, or fish flows create a wide varial zone in the river, which becomes biologically unproductive.	–
Mountain whitefish migrate up system to spawn – same as westslope cutthroat trout issues.	–	–	–	The planned reservoir refill date in the NOAA Fisheries BiOp of Jun 30 will cause the dam to spill in roughly the highest 30% of water years. This is because inflows remain above turbine capacity into Jul on high years. That means the reservoirs fill and have no remaining capacity to control spill, which causes gas supersaturation problems.	–
Northern pikeminnow, largescale and longnose suckers, sculpins – mostly tributary production.	–	–	–	Flow fluctuations caused by power, flood control, or fish flows cause sediments to build up in river cobbles. Before dams were built, these sediments normally deposited themselves in floodplain zones that provided the seedbeds necessary for the establishment of willow, cottonwood, and other riparian plant communities. Young cottonwood stands are needed to replace mature stands being lost to natural stand aging, as well as adverse human activities such as hardwood logging and land clearing.	–
Northern pikeminnow predation in shallow water, suspect spawning. Dewatering of bays in early summer could affect spawning success by dewatering.	–	–	–	–	–
Varial zones drawdown during migration periods can increase exposure of native fish to predation (birds, mammals, etc.).	Hungry Horse elevations, Apr to Jul.	–	–	Adults upstream: May to Jun	–
Emigration juveniles: Jun to Jul	–	–	–	–	–

Affected Environment Important Relationships/Criteria	Affected Environment Metric	Environmental Consequences H&H and Water Quality Outputs	Environmental Consequences Effects to Resource NAA	Environmental Consequences Notes	Citations
South Fork Flathead River below Hungry Horse					
Temperature control operations control lake trout interactions.	–	–	–	Can come up in late fall and winter. In Jul, when native fish coming out of natal tributaries, lake trout have moved out due to temperature control.	–
Unnaturally high flows in summer.	–	–	–	–	–
Altered hydrograph that impacts riparian vegetation.	–	–	–	–	–
Flood control or fish flows that affect sediment/deposition and transport.	–	–	–	–	–
TDG	–	–	–	–	–
Competition with non-native (lake trout)	–	–	–	–	–
Water temperatures	–	–	–	–	–
Flathead River – same relationships as South Fork, just attenuated by downstream and addition of flathead flows.	–	–	–	Pygmy whitefish in Flathead River may make a spawning run	–
Flathead Lake (see bull trout section)					
Anything in operations that impacts productivity?	–	–	–	–	–
Temperature?	–	–	–	–	–
Shrimpies	–	–	–	–	–
Competition with non-native (lake trout) – Clark Fork	Clark Fork	–	–	Temperature and flow effects may tip the scales towards non-native populations from the reservoir.	–
Game Fish					
Flathead Lake (important game fish are westslope cutthroat trout and bull trout – covered in their own sections)	–	–	–	–	–
–	Flathead River 79.431 and/or 96.816	–	–	Potential temperature or lake level effects. Very low chance of any effects due to project operations, but look at Hungry Horse Dam in Flathead Lake for an potential effects.	–
Perch – spawning, aquatic vegetation, changing elevations? Likely not enough to make any change, dewater eggs, etc., not an issue.	–	–	–	–	–
Lake whitefish – dependent on good perch spawn.	–	–	–	–	–
Smallmouth Bass	–	–	–	–	–
Lake trout	–	–	–	–	–
Northern Pike	–	–	–	–	–
Potentially, walleye	–	–	–	–	–

Affected Environment Important Relationships/Criteria	Affected Environment Metric	Environmental Consequences H&H and Water Quality Outputs	Environmental Consequences Effects to Resource NAA	Environmental Consequences Notes	Citations
Kokanee					
Flathead Lake					
In Flathead Lake, there used to be kokanee, but this collapsed due to mysis and lake trout interactions.	Flathead River 79.431 and/or 96.816.	–	–	–	–

The table of end of month elevations was summarized from outputs of the hydrology modeling. This information was used in qualitative discussions, as well as an input to figuring the end of month euphotic zone and surface area.

Table 3-71. End of Month Elevations (ft) of Hungry Horse Reservoir

Month	NAA Wet	NAA Dry	NAA Avg	MO1 Wet	MO1 Dry	MO1 Avg	MO2 Wet	MO2 Dry	MO2 Avg	MO3 Wet	MO3 Dry	MO3 Avg	MO4 Wet	MO4 Dry	MO4Avg
October	3546	3546	3547	3542	3541	3541	3546	3546	3547	3541	3538	3541	3541	3538	3541
November	3544	3541	3546	3538	3536	3538	3544	3542	3546	3538	3535	3538	3538	3535	3538
December	3542	3536	3544	3534	3531	3536	3542	3536	3544	3533	3531	3534	3533	3531	3535
January	3534	3530	3538	3531	3525	3532	3527	3530	3528	3529	3524	3530	3531	3524	3530
February	3522	3524	3531	3519	3519	3526	3508	3524	3521	3519	3518	3526	3519	3518	3526
March	3498	3522	3526	3497	3514	3521	3486	3521	3516	3497	3514	3520	3497	3514	3520
April	3477	3528	3522	3477	3521	3519	3473	3528	3516	3478	3520	3518	3477	3520	3518
May	3511	3550	3541	3511	3545	3539	3507	3542	3538	3511	3544	3539	3511	3544	3538
June	3553	3559	3559	3553	3557	3559	3554	3555	3558	3554	3556	3559	3553	3550	3558
July	3559	3554	3559	3559	3553	3558	3560	3554	3559	3559	3553	3558	3559	3547	3557
August	3555	3547	3555	3553	3546	3552	3556	3549	3555	3553	3546	3552	3553	3539	3551
September	3550	3540	3550	3546	3539	3546	3550	3544	3550	3546	3539	3546	3546	3530	3546

To calculate euphotic zone, the team first found the total volume of the reservoir at the end of each month using known volumes at elevations for Hungry Horse Reservoir. The depth of productive zone was calculated by finding the total reservoir volume at the end of each month from the previous calculation and subtracting the volume of non-productive depth. The depth of the euphotic zone varies by month, getting deeper through the summer months; the following depths were used in calculations:

- May: 30 feet
- June: 30 feet
- July: 50 feet
- August: 70 feet
- September: 80 feet

Table 3-72. End of Month Euphotic Zone (Acre-Feet)

Month	NAA Wet	NAA Dry	NAA Avg	MO1 Wet	MO1 Dry	MO1 Avg	MO2 Wet	MO2 Dry	MO2 Avg	MO3 Wet	MO3 Dry	MO3 Avg	MO4 Wet	MO4 Dry	MO4 Avg
October	1456748	1456829	1464916	1420897	1413025	1416882	1457316	1456829	1467252	1416547	1391075	1414284	1416547	1390064	1414284
November	617552	609341	624264	599096	592718	600836	618031	612035	624264	598916	590271	600235	598916	590271	599965
December	612005	592386	616531	588547	578843	592869	613023	592266	617011	585452	578504	588819	585816	578504	591572
January	588335	574386	600356	578411	558132	580288	564744	574510	570309	573700	557161	576495	577578	557161	576372
February	549502	557698	579704	540009	538194	562007	500826	557430	546977	538997	535164	561579	538229	535303	561612

Month	NAA Wet	NAA Dry	NAA Avg	MO1 Wet	MO1 Dry	MO1 Avg	MO2 Wet	MO2 Dry	MO2 Avg	MO3 Wet	MO3 Dry	MO3 Avg	MO4 Wet	MO4 Dry	MO4 Avg
March	472877	548639	561052	471344	522332	544230	438764	545518	527017	471400	520616	543952	471037	520885	543116
April	411772	569929	549812	412334	546700	537252	397605	569897	529385	413084	543917	536451	412334	543917	535686
May	510997	635389	607725	511157	619474	602304	498724	611766	598556	513272	618512	602036	511190	617821	600596
June	645447	662074	662913	645478	657843	662447	647851	651718	660706	646894	654918	662602	645478	636425	661733
July	1057686	1030354	1055107	1056069	1027234	1051713	1059048	1027593	1056170	1056271	1026671	1051814	1056018	991584	1047599
August	1376345	1316650	1371494	1360008	1309545	1354349	1377094	1327884	1372238	1360008	1308624	1354422	1359787	1256439	1341887
September	1489407	1408156	1489248	1457154	1396713	1456991	1489487	1437925	1489327	1457154	1395537	1456991	1457154	1249532	1452356

Table 3-73. End of Month Surface Area Table

Month	NAA Wet	NAA Dry	NAA Avg	MO1 Wet	MO1 Dry	MO1 Avg	MO2 Wet	MO2 Dry	MO2 Avg	MO3 Wet	MO3 Dry	MO3 Avg	MO4 Wet	MO4 Dry	MO4 Avg
October	22345	22345	22448	21936	21833	21833	22345	22345	22448	21833	21527	21833	21833	21527	21833
November	22140	21833	22345	21527	21322	21527	22140	21935	22345	21527	21220	21527	21527	21220	21527
December	21935	21322	22140	21119	20812	21322	21935	21322	22140	21017	20812	21119	21017	20812	21221
January	21119	20710	21527	20812	19522	20812	20312	20710	20511	20611	20113	20710	20812	20113	20710
February	19913	20113	20812	19618	19522	20212	18409	20113	19814	19618	19426	20212	19522	19522	20212
March	17388	19913	20212	17280	19138	19714	16126	19714	19234	17280	19042	19714	17280	19042	19714
April	15213	20511	19913	15213	19814	19522	14674	20511	19330	15213	19714	19522	15213	19714	19522
May	18754	22652	21833	18754	22140	21527	18294	21935	21527	18850	22140	21527	18754	22140	21527
June	23072	23602	23602	23072	23496	23602	23072	23284	23602	23072	23390	23602	23072	22755	23602
July	23707	23178	23602	23707	23072	23602	23707	23072	23707	23707	23072	23602	23707	22345	23496
August	23284	22448	23178	23072	22345	22967	23284	22550	23178	23072	22345	22967	23072	21527	22755
September	22755	21731	22755	22345	21527	22345	22755	22140	22755	22345	21527	22345	22345	20710	22243

PEND OREILLE

Table 3-74. Columbia River Pend Oreille Regional Qualitative Effects Analysis Matrix

Affected Environment Important Relationships/Criteria	Affected Environment Metric	Environmental Consequences NAA	Environmental Consequences MO1	Environmental Consequences MO2	Environmental Consequences MO3	Environmental Consequences MO4	Notes
Lake Pend Oreille Bull Trout							
Temperatures over 15°C are limiting to bull trout distributions.	Temperatures in FMO habitat from November through June.	Nov through Jun (when bull trout are present) surface temperatures range from 4°C to 15°C, while deepwater (>20 meters) temperatures rarely exceed 15°C. Cold water habitats occur year round, while surface water temperatures from Jun through Oct may be too warm for bull trout. Under the NAA, Lake Pend Oreille deepwater temperatures are suitable for bull trout year round, while shallow water supports bull trout from Nov through Jun.	No difference from NAA.	No difference from NAA.	No difference from NAA.	No difference from NAA. There are no changes to operations expected at Albeni Falls Dam for median and high water years under MO4. For the drier 40 percent of years, Lake Pend Oreille will be around 2.5 feet lower in the summer due to higher outflows from Albeni Falls Dam. Due to this change, it is possible that higher summer flows might increase or decrease the temperature (±0.9°F to 1.8°F) in the Pend Oreille River, depending on flow and weather conditions.	Surface water releases from Albeni Falls Dam exceed 20°C (68°F) from early Jul through late Sep. Any fish entrained will be lost to the system. USFWS 2015, Water Quality Appendix 7-3.

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Affected Environment Important Relationships/Criteria	Affected Environment Metric	Environmental Consequences NAA	Environmental Consequences MO1	Environmental Consequences MO2	Environmental Consequences MO3	Environmental Consequences MO4	Notes
Entrainment – increased flows could increase bull trout entrainment through Albeni Falls Dam.	Albeni Falls outflow from Mar through Jun.	Entrainment most common in Mar through June when flows are high. Mean flows in Mar through Jun = 37,815 cfs Under current conditions, an unknown number of bull trout are entrained through Albeni Falls Dam and lost to the system. Under the NAA, this is likely to continue.	No difference from NAA. Hydrograph from MO1 overlays NAA hydrograph. Mean flows from Mar through Jun = 37,329 cfs (-486 ~ 1.3%).	Slightly lower flows in Mar through Jun would decrease risk of entrainment for MO2 compared to NAA. Mean flows from Mar through Jun = 36,912 cfs (-903 ~ 2.4%).	No difference from NAA. Hydrograph from MO3 nearly overlays NAA hydrograph. Mean flows from Mar through Jun = 37,257 cfs (-558 ~ 1.5%).	No difference from NAA. Hydrograph from MO3 nearly overlays the NAA hydrograph. Mean flows from Mar through Jun = 37,447 cfs (-118 ~ 0.3%).	Bull trout are likely headed downstream for winter migrations naturally in Oct and Nov. Electroshocking surveys used to capture bull trout that have been entrained through Albeni Falls Dam, but capture efficiency is very low. These data are only good for presence/absence of bull trout. May affect Priest River fish that head downstream and are lost. Most within Lake Pend Oreille are large enough populations, but probably without large genetic effects. If fish trap and haul is completed at Albeni Falls Dam, potential to reduce entrainment. Kalispel Tribe and EWU may have numbers. Corps, 2018. Normandeau, 2014.
Bull trout need robust kokanee populations for adequate forage. (See kokanee for effects).	Kokanee numbers.	Kokanee increased from ~100 adult fish/ha in 2008 to 377 adults/ha in 2016. Under current conditions, kokanee will continue to provide a good forage base for adult bull trout.	Status of the kokanee population in the future is unknown. There appears to be no difference between MO1 and NAA that would change the future of the kokanee population.	Status of the kokanee population in the future is unknown. There appears to be no difference between MO2 and NAA that would change the future of the kokanee population.	Status of the kokanee population in the future is unknown. There appears to be no difference between MO3 and NAA that would change the future of the kokanee population.	Status of the kokanee population in the future is unknown. There appears to be no difference between MO4 and NAA that would change the future of the kokanee population.	Current operations are good for kokanee populations ~ good for bull trout. This metric does not appear to detect any differences in the alternative. Andy Dux, 2019.
Albeni Falls operations affect sedimentation and erosion from lake shorelines. Could indirectly affect bull trout access to tributary mouths due to sedimentation.	Lake elevations in Sep affect tributary access, and amount of fluctuations.	Lowest elevations (2051) are reached in mid-Nov. Elevations go back up starting in early Apr, and reach full pool on Jul 1. During upstream migrations (May through Sep), water elevations are rising or full (2062). In dry years, there are some sites that may have issues (e.g., Johnson Creek at Clark Fork Delta). Current operations rarely affect tributary access during spring and summer. Operations would continue to provide access to most tributaries under current conditions.	No difference from NAA. Mean elevation in Sep is 2061.6.	No difference from NAA. Mean elevation in Sep is 2061.6.	No difference from NAA. Mean elevation in Sep is 2061.6.	In dry years, MO4 would not reach full pool. Mean elevation in September = 2059.7 ~ 2 feet lower than NAA. On dry years, access to spawning streams may be more limited under MO4 than the NAA.	Indirect effect on bull trout habitat, may alter tributary mouth habitats. Bull trout move into tributaries when lake levels are high during May and June. Gold and Granite Creeks may be more impacted as fish move into these tributaries later in the year. Would drawdown in late September affect access? Future alternatives may change that? Check lake elevations in MOs. Corps, 2018.

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Affected Environment Important Relationships/Criteria	Affected Environment Metric	Environmental Consequences NAA	Environmental Consequences MO1	Environmental Consequences MO2	Environmental Consequences MO3	Environmental Consequences MO4	Notes
Large woody debris are not currently allowed to enter Lake Pend Oreille (boating safety). This habitat is essential to bull trout in stream settings.	Shoreline habitat and woody debris.	A log boom diverts the debris from entering the lake. These are piled on shore. Does this affect topography and shoreline habitat? The loss of woody debris along the shoreline is not likely to negatively impact bull trout, because these were historically found in shallow warm water used only seasonally.	No difference from NAA.	No difference from NAA.	No difference from NAA.	No difference from NAA.	Bull trout need cold water. The debris historically settled out in shallow water habitats not likely to be used by bull trout. Warmer surface temperatures at these sites would benefit warm water species and not bull trout. Important in streams not so much in lakes.
Flexible winter power operations result in changing lake elevations in the winter. Greater range of elevations in winter for power production flexibility allows 5-foot operating range (from 2051 to 2056) – may increase erosion rates.	Nov to Mar lake elevations.	See Albeni Falls operations above. In median years, the models do not project elevation fluctuations. Current operations are not likely to directly adversely affect bull trout. However, winter fluctuations are likely to increase erosion of lake bed at lower elevations ~ 2051 to 2056 and may impact forage fish production.	No difference from NAA.	No difference from NAA.	No difference from NAA.	No difference from NAA.	Outmigration of subadults from Priest River in winter could move downstream and be entrained. Cutthroat trout have been entrained (Fred), could also happen to bull trout. No data are available for fluctuations in the MOs – this metric is not useful in selecting an alternative. Corps and BPA, 2011.
Cabinet Gorge blocked upstream migration of bull trout in 1953. May have lost much of the genetics for that population. Some passage was recently restored through temporary trap and haul (2001). To be replaced by permanent structure in 2018.	Numbers of bull trout passing Cabinet Gorge.	35 bull trout per year are hauled above Cabinet Gorge Dam. See Avista Contacts. Under current conditions, bull trout will continue to have passage above Cabinet Gorge Dam.	No difference from NAA.	No difference from NAA.	No difference from NAA.	No difference from NAA.	Cabinet Gorge efforts for passage, Lake Pend Oreille bull trout historically ran up the Clark Fork River. Cabinet Gorge blocked those runs, but now there is passage again. Annual reports show numbers/percent of fish from upstream populations. This metric is not useful in selecting an alternative as none of the alternatives change access to upstream habitats.
Predation and competition from walleye populations may limit bull trout populations. Walleye forage on kokanee populations. In addition, operations may favor walleye and other warmwater fish during the time that bull trout subadults are migrating downstream into Pend Oreille River through river lake interface. Bull trout can enter the lake until July, when temperatures are too warm.	Walleye populations	Walleye populations are expanding rapidly. From 2011 to 2017, relative abundance doubled every 3 years (citation). Relative abundance numbers (2017 report – Matt). Under current conditions, walleye populations are expected to expand and compete with and prey on adult and subadult bull trout respectively.	No difference from NAA.	No difference from NAA.	No difference from NAA.	No difference from NAA.	Walleye trend increasing, affects bull trout. 2011 to 2017 relative abundance doubled every 3 years. Been at low level for a time, but increasing trend now; in-lake recruitment. Also increasing below Albeni Falls. Entrainment from upriver – suspect with commensurate increase in downstream populations.

Affected Environment Important Relationships/Criteria	Affected Environment Metric	Environmental Consequences NAA	Environmental Consequences MO1	Environmental Consequences MO2	Environmental Consequences MO3	Environmental Consequences MO4	Notes
Northern pike – predation on bull trout and competition for kokanee.	Northern pike consumption. Metric does not change between alternatives.	Studies in Montana show that northern pike eat bull trout. Bull trout and westslope cutthroat are around 5% of the diet in upriver sites. Northern pike numbers are low and future populations are currently undetermined at this time in Lake Pend Oreille. While northern pike do eat bull trout, their numbers are low in Lake Pend Oreille, and any effect is undetermined.	No difference from NAA.	No difference from NAA.	No difference from NAA.	No difference from NAA.	Pike are present. Rocky Mountain Research station is looking at pike distribution patterns. Entrainment from upstream and in-lake recruitments. Muhlfeld, 2008.
Lake trout compete with bull trout – primarily for kokanee. This predation is not directly affected by project operations, but is included for context.	Lake trout populations	Lake trout harvest also resulted in over 14,000 bull trout being harvested, so it was hard to estimate the benefit from lake trout suppression efforts. Lake trout catch rates are down, kokanee numbers are up (100 to 377 fish/ha), and bull trout redd counts are down. Under the NAA, competition with lake trout will continue at reduced levels and bull trout are likely to persist in Lake Pend Oreille.	No difference from NAA.	No difference from NAA.	No difference from NAA.	No difference from NAA.	Lake trout suppression program 2006 to 2016 – published 2019. Successful in removing lake trout, but bull trout populations still low. Adult kokanee populations increased from 100 fish/ha to 377 fish/ha. Historically negative affected kokanee with dam ops., link to lake trout suppression. Abundance modeling currently showing growth of bull trout populations (Matt). Andy Dux, 2019.
Downstream of Albeni Falls Dam							
Bull trout are scarce below the dam due to habitat limitations in temperature.							
Albeni Falls blocks upstream migration back into the system where temperatures allow survival. Fish entrained into the river below Albeni Falls Dam are lost when temperatures increase in summer. Entrainment is likely highest during spring migration when bull trout are moving and flows are highest.	Entrainment and river water temperature.	Entrainment most common March to June when flows are high. Temperatures over 15°C limit movement, over 20°C can be lethal. River temperatures reach 15°C in June and lethal temperatures in July. Under current conditions, an unknown numbers of bull trout are entrained through Albeni Falls Dam and lost to the system. Under the NAA, this is likely to continue.	No difference from NAA.	No difference from NAA.	No difference NAA.	No difference from NAA.	Very few captured trace back to Lake Pend Oreille tributaries. Reintroduction efforts. Recovery efforts, FERC relicensing. There is now passage at Box Canyon. Corps, 2018.

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Northern pike predation. Below Albeni Falls Dam, northern pike have expanded and are apex predators in this system.	Numbers of bull trout entrained into lower river – numbers of northern pike.	Unknown numbers of bull trout are entrained. Pike numbers have increased and are being suppressed (over 17,000 removed since 2012 ~ 90% reduction). Under current conditions, an unknown number of bull trout will continue to be entrained and some may be consumed by northern pike. Not likely to affect as these fish are lost to the lake.	No difference from NAA.	No difference from NAA.	No difference from NAA.	No difference from NAA.	Pike are a big deal below Albeni Falls. Suppression of pike occurring in Box Canyon Reservoir since 2012. These fish experienced exponential growth up to when suppression efforts began. Also began suppression efforts at Boundary Dam.
Temperatures in the lower Pend Oreille River – bull trout may not survive below Albeni Falls Dam during high summer temperatures from June through October. May be thermal refuges in the system.	Water temperature in Pend Oreille River.	Temperature profiles from WQ Appendix show that temperatures between June and October are likely to hit for bull trout in the river section of the lake. Temperatures reach 15°C in June and lethal temperatures by July. Surrogate temperatures from Lake Pend Oreille. Under current conditions, unknown numbers of bull trout are entrained through Albeni Falls Dam and lost to the system. Under the NAA, this is likely to continue.	–	–	–	On dry years, the lake may be as much as 2.5 feet lower for MO4 compared to NAA. Lower water will likely be associated with higher water temperatures. Under MO4, on dry water years, elevated temperatures may exacerbate the current conditions.	LPR river arm near the dam does not stratify so temperatures get hot in the summer before leaving the lake. Water Quality Appendix 7-3.
Walleye expanded in Box Canyon and Boundary Reservoirs, and expected to continue to rise.	Walleye populations	Unknown number of bull trout are entrained. Walleye numbers are expected to rise in Box Canyon and Boundary Reservoirs.	–	–	–	–	–
Unknown number of bull trout will continue to be entrained and some may be consumed by walleye. Not likely to affect.	No difference from NAA.	No difference from NAA.	No difference from NAA.	No difference from NAA.	This is not likely a driving factor as bull trout cannot survive well in this reach regardless of predator numbers. While numbers of walleye are increasing, they are still relatively low.	–	–

Affected Environment Important Relationships/Criteria	Affected Environment Metric	Environmental Consequences NAA	Environmental Consequences MO1	Environmental Consequences MO2	Environmental Consequences MO3	Environmental Consequences MO4	Notes
Potential indirect effects: Brook trout populations in tributaries could hybridize with bull trout.	Extent of brook trout populations.	Limited brook trout populations in the mainstem habitats. Brook trout locations unrelated to project operations. Brook trout hybridization with bull trout is not likely to be impacted by any of the project alternatives.	No difference from NAA.	No difference from NAA.	No difference from NAA.	No difference from NAA.	–
Westslope Cutthroat Trout							
Upstream tributary access was blocked in 1953 when Cabinet Gorge Dam was completed. Loss of genetics and habitat. Access was restored in 2016 when limited numbers of westslope cutthroat trout were transported.	Access – number of westslope cutthroat trout passing Cabinet Gorge.	Need number of westslope cutthroat trout allowed upstream of Cabinet Gorge Dam. 40 transported in 2016 and 41 in 2017. Avista, 2017. Unknown numbers of westslope cutthroat trout will continue to gain passage above Cabinet Gorge Dam.	No difference from NAA.	No difference from NAA.	No difference from NAA.	No difference from NAA.	Tributary access was blocked completely. Trap and haul started 2016 (NAA).
Entrainment: Cutthroat trout can be entrained through Albeni Falls, isolated from habitat. Priest River fish overshooting and getting entrained. Westslope cutthroat trout are cued to spawn when water temperatures reach ~ 10°C (Liknes and Graham, 1988) or about May in LPR.	Numbers of westslope cutthroat trout entrained in May and June during migration. Flows in May and June.	Reports of more westslope cutthroat trout from bull trout below Albeni Falls Dam. Genetic map created for identifying fish that should pass. Highest entrainment likely during spring high spill season. Mean flow = 54,442 cfs. Albeni Falls Dam will continue to entrain unknown numbers of westslope cutthroat trout into the Pend Oreille River.	Mean flow = 53,776 cfs. No difference from NAA.	Mean flow = 52,965 cfs ~ 2.7% less flow. No difference from NAA.	Mean flow = 53,705 cfs. No difference from NAA.	No difference from NAA.	Cutthroat found relatively often below Albeni Falls come down out of the lake and don't go up the Priest River system. Genetics work shows Priest origins of entrained fish. Same effect as bull trout. Liknes and Graham, 1988.
River below Albeni Falls Dam							
Walleye expansion in Box Canyon and Boundary Reservoirs expected to forage on and compete with westslope cutthroat trout. Walleye numbers are expected to continue to rise.	Walleye population numbers.	Walleye numbers are expected to rise in Box Canyon and Boundary Reservoirs. Cutthroat in Pend Oreille River are susceptible to predation. Walleye will consume and unknown number of westslope cutthroat trout in the Pend Oreille River.	No difference from NAA.	No difference from NAA.	No difference from NAA.	No difference from NAA.	This is not likely a driving factor as westslope cutthroat trout cannot survive well in this reach, regardless of predator numbers. While numbers of walleye are increasing, they are still relatively low.

Affected Environment Important Relationships/Criteria	Affected Environment Metric	Environmental Consequences NAA	Environmental Consequences MO1	Environmental Consequences MO2	Environmental Consequences MO3	Environmental Consequences MO4	Notes
Northern pike predation. Below Albeni Falls Dam, northern pike have expanded and are apex predators in this system.	Numbers of northern pike.	Pike numbers have increased and are being suppressed (over 17,000 removed since 2012 ~ 90% reduction). Cutthroat in the Pend Oreille River are susceptible to predation. Northern pike will consume and unknown numbers of westslope cutthroat trout in the Pend Oreille River.	No difference from NAA.	No difference from NAA.	No difference from NAA.	No difference from NAA.	Pike are a big deal below Albeni Falls. Suppression of pike occurring in Box Canyon Reservoir since 2012, exponential growth up to suppression efforts. Also began suppression efforts at Boundary Dam. This is not likely a driving factor as westslope cutthroat trout cannot survive well in this reach regardless of predator numbers.
Temperatures in lower Pend Oreille River – westslope cutthroat trout may not survive below Albeni Falls Dam during high summer temps (Bear et al., 2007) from June through October. Temperatures over 18°C are limiting for westslope cutthroat trout. Upper lethal temperature is ~20°C. Thermal refuges may be present.	Water temperature in the Pend Oreille River over 18°C.	Temperature profiles from WQ Appendix show that temperatures between June and October are likely too hot for westslope cutthroat trout in the river section of the lake and downstream. Temperatures reach 15°C in June and lethal temperatures by July. Under current conditions in unknown numbers of westslope cutthroat trout are entrained through Albeni Fall Dam and likely lost to the system. Under the NAA, this is likely to continue.	No difference from NAA.	No difference from NAA.	No difference from NAA.	On dry years, the lake may be as much as 2.5 feet lower for MO4 compared to the NAA. Lower water will likely be associated with higher water temperatures. Under MO4, on dry water years, elevated temperatures may exacerbate the current conditions.	The Lake Pend Oreille river arm near the dam does not stratify, so temperatures get hot in the summer before leaving the lake. Resident populations in the tributaries; historically was fluvial or adfluvial component. Now too warm in the summer. No passage to get to thermal refuge in Lake Pend Oreille. Water Quality Appendix 7-3. Bear et al., 2007.
Kokanee							
Kokanee are main forage item for predator fish in Lake Pend Oreille. There are two strains of kokanee – early tributary spawners and late lakeshore spawners. Hatchery programs are used to increase numbers.	–	No relationship. Just species facts.	–	–	–	–	No relationship, just facts about the kokanee populations.
Effect of water level fluctuations on kokanee egg incubation, water level drawdowns during, or shortly after spawning would negatively impact kokanee populations. This metric does not appear to separate the alternatives – suggest deleting.	Pool elevation (Nov to May).	Pool elevations rise from 2052 to 2055 between Nov and May on an average year. Current lake operations do not negatively impact kokanee spawning or egg incubation.	Pool elevations are similar to NAA – no difference from NAA.	Pool elevations are similar to NAA – no difference from NAA.	Pool elevations are similar to NAA – no difference from NAA.	Pool elevations are similar to NAA – during this time, no difference from NAA.	Tried winter elevation changes in tests, did not find a better operation for kokanee. Current lake level management does not negatively affect kokanee. Gets lake levels down before kokanee spawn and, once they spawn, they are wetted. Whitlock et al., 2015a and b, and 2018.

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Affected Environment Important Relationships/Criteria	Affected Environment Metric	Environmental Consequences NAA	Environmental Consequences MO1	Environmental Consequences MO2	Environmental Consequences MO3	Environmental Consequences MO4	Notes
Flexible winter power operations results in changing lake elevations in the winter. Greater range of elevations (2051 to 2056) in winter, may increase erosion rates during kokanee spawning.	Pool elevation in winter months.	Current modeling from H&H cannot show power peaking operations. Current lake operations do not negatively impact kokanee spawning or egg incubation.	No difference from NAA.	No difference from NAA.	No difference from NAA.	No difference from NAA.	Power peaking operations raise and lower water elevations during winter. Can cause erosion of spawning habitats? No evidence this is causing problems.
Kokanee exploitation – relationship to water elevation.	Angler access and exploitation.	Anglers have access except in low water years when access could be limited on dry years. Under the NAA, kokanee exploitation, as measured by angler access will not limit kokanee populations.	No difference from NAA.	No difference from NAA.	No difference from NAA.	Water elevations during summer months will be ~2.5 feet lower on driest years. Will this impact angler access? In low water years, access will not be limited. MO4 will not refill on driest years – will be left 2.5 feet below full pool.	The exploitation rate of age-2 kokanee is estimated to be approximately 1.4%; of age-3 kokanee, approximately 11%; and of age-4 kokanee, approximately 25%. Harvest limit is 15 fish a day, not thought to be a driving factor. Operations can affect access to lake in winter months (boat ramps), but there are few anglers during that time period. Not affected by operations except in winter when low water levels limit access – low fishing pressure. Corps, 1998 EIS.
Continuing to manage predation is key. Large numbers of predators control kokanee populations (lake trout, Gerard rainbow trout, and walleye).	Predator numbers.	Walleye populations are increasing, while lake trout have been reduced. Rainbow trout are constant. Predator populations appear to be the primary driver for kokanee populations in Lake Pend Oreille. Kokanee are expected to provide a fishery and forage for predators including bull trout in future years.	No difference from NAA.	No difference from NAA.	No difference from NAA.	No difference from NAA.	Walleye numbers have increased in recent years. Appears some threshold has been exceeded. Lake and mysis shrimp are controlling factors for kokanee populations in Lake Pend Oreille. Mysis compete for food resources and lake trout (other predators as well) consume kokanee. Corsi et al., 2019.
Mysis control carrying capacity for kokanee. Predators control kokanee populations.	Mysis and predator numbers.	–	No difference from NAA.	No difference from NAA.	No difference from NAA.	No difference from NAA.	Operations don’t affect mysis populations reduce spawning success or productivity of the kokanee population, while high predator populations (lake trout) correspond to reduced kokanee numbers and biomass. Corsi et al., 2019.
Entrainment – kokanee entrained through Albeni Falls Dam, high flows associated with entrainment.	Kokanee numbers entrained flows in May and June.	–	Mean flow = 53,776 cfs. No differences from NAA.	Mean flow = 52,965 cfs ~ 2.7% less flow. May be slight reduction in risk of entrainment under MO2.	Mean flow = 53,705 cfs. No difference from NAA.	Mean flow = 53,992 cfs. No difference from NAA.	Entrainment not likely limiting kokanee in Lake Pend Oreille. Assume entrainment occurring in high water events – Bill (personal communication) has seen kokanee in Box Canyon and Boundary Reservoirs following high flow events.
Below Albeni Falls, kokanee not a significant part of fishery.	–	No effect.	No effect.	No effect.	No effect.	No effect.	Kokanee are not a significant part of the fish community below Albeni Falls Dam.

Affected Environment Important Relationships/Criteria	Affected Environment Metric	Environmental Consequences NAA	Environmental Consequences MO1	Environmental Consequences MO2	Environmental Consequences MO3	Environmental Consequences MO4	Notes
Northern Pikeminnow							
Pikeminnow are part of native fish tab – they are a minor player here, but part of the native fish.							
Walleye							
Walleye populations expanding in Lake Pend Oreille. They hang out in habitats submerged in summertime. Pend River. They also hang out at tributary mouths and forage on outmigrating kokanee, westslope cutthroat trout, and bull trout.	Not a metric, but a statement of current condition.	–	–	–	–	–	–
Spawn in spring beginning at ~ 4°C over benthic habitats less than 10 feet deep. Spawning in April and May.	Quality of shoreline habitat available. Temperatures in spring.	Water temperatures are as low as 3°C in Feb and reach 4°C in Mar, 8°C in Apr, and 12°C in May. Cobble and gravel slopes are available in much of the lake. Unknown impact on walleye spawning. Elevated stable water levels may improve summer habitat for walleye.	No difference from NAA.	No difference from NAA.	No difference from NAA.	No difference from NAA.	Spawning in river deltas and backwaters (Pack River and Clark Fork). Water Quality Appendix 7-3.
Fry are pelagic and feed on zooplankton. Lower plankton numbers lead to reduced fry survival.	Productivity.	Lake Pend Oreille is classified as oligotrophic to mesotrophic (low to moderate productivity). Currently plankton numbers do not appear to be limiting for walleye fry.	No difference from NAA.	No difference from NAA.	No difference from NAA.	No difference from NAA.	Recent increases in walleye populations is evidence that there are not limitations to fry survival. Moderate numbers of phytoplankton were sampled with increases in the last 8 years. Water Quality Appendix 7-3.
Stable water level is critical for walleye spawning success. Drawdowns during spawn would leave eggs and larvae dry.	Reservoir levels mid-Mar to mid-May.	Water elevations under NAA start a 2051 and go up to 2059 by the end of spawning and incubation. Winter operations can fluctuate as much as 5 feet during early Mar and may impact a small portion of the walleye spawn. Unknown impact on walleye spawning.	No difference from NAA.	No difference from NAA.	No difference from NAA.	No difference from NAA.	Current hydrograph supports spawning and recruitment. Walleye spawn when lake is filling, so eggs and larvae should stay submerged. Spawning in Lake Pend Oreille occurs in Pack River delta area, and Clark Fork River delta. Caught ripe males at Sandpoint. Water Quality Appendix 7-3.
Smallmouth Bass							
Smallmouth in Lake Pend Oreille is a popular fishery, and impacts to other fish are probably very minor. Suggest the team consider in the gamefish tab.	Not a metric, but a statement of current condition.	–	–	–	–	–	–

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Affected Environment Important Relationships/Criteria	Affected Environment Metric	Environmental Consequences NAA	Environmental Consequences MO1	Environmental Consequences MO2	Environmental Consequences MO3	Environmental Consequences MO4	Notes
Temperature effects to spawning – smallmouth bass spawning initiated at ~ 13°C.	Lake temperature from mid-May through Jun.	Lake Pend Oreille reaches 13°C at about mid-May. The lake currently provides water temperatures that support smallmouth bass spawning. No effect.	No difference from NAA.	No difference from NAA.	No difference from NAA.	No difference from NAA.	Smallmouth may nest more than once if temperatures drop after the first attempt. Edwards et al., 1983.
Pool elevation effects on spawning habitat availability – water fluctuations during spawning and egg incubation can reduce recruitment – water levels drop and dry up nests.	Lake elevation mid-May through Jun.	Water elevation increases from 2057 to 2062 during this time period. Lake elevations will not negatively impact smallmouth bass spawning or egg development. No effect.	No difference from NAA.	No difference from NAA.	No difference from NAA.	On dry years, under MO4 Lake Pend Oreille may be as much as 2.5 feet lower in Jun through Jul compared to NAA. However, the team does not anticipate water level fluctuations that would desiccate smallmouth bass nests during this time. No effect on smallmouth bass nests.	Edwards et al., 1983.
Temperature effects on egg development – require temperatures from 13°C to 25°C for normal growth.	Water temperature from mid-May through Jul	Lake Pend Oreille reaches 13°C about mid-May, 17°C by mid-Jun, and over 20°C in Jul. The lake currently provides water temperatures that support smallmouth bass embryo development. No effect.	No difference from NAA.	No difference from NAA.	No difference from NAA.	On dry years, under MO4 Lake Pend Oreille may be as much as 2.5 feet lower in Jun through Jul compared to NAA. However, the team does not anticipate changes in water temperature in the lake. We would expect higher water temperatures downstream of Lake Pend Oreille in the Pend Oreille River.	Edwards et al., 1983.
Pool elevation effects on fingerling survival (mean elevation May through Oct).	Reservoir elevation May through Oct (Edwards et al., 1983).	Lake Pend Oreille water levels are generally raised from May to Jul and then held constant until Sep and drop rapidly until Nov. The lake water levels under NAA may negatively impact smallmouth bass fry or fingerling at the end of rearing in Sep and Oct by forcing them to leave nesting and rearing areas.	No difference from NAA.	No difference from NAA.	No difference from NAA.	On dry years, under MO4 Lake Pend Oreille may be as much as 2.5 lower in Jun through Sep compared to the NAA, but would hold these lower water levels stable for 1 month longer. Stable is better for nesting smallmouth bass and expect reduction in risk of displacement for smallmouth bass in MO4.	Edwards et al., 1983.
Downstream – long-time resident fishery, numbers have increased in Box Canyon. Important component of the fishery.	Not a metric, but a statement of current condition.	–	–	–	–	–	–

Affected Environment Important Relationships/Criteria	Affected Environment Metric	Environmental Consequences NAA	Environmental Consequences MO1	Environmental Consequences MO2	Environmental Consequences MO3	Environmental Consequences MO4	Notes
Northern Pike							
Upstream of Albeni Falls							
Pool elevations can affect pike habitat availability. Lake bathymetry would provide very little habitat without the lake level up to inundate slough and inlet areas. Northern pike are seen at Clark Fork delta and slough habitats. Seem increasingly in creel.	Lake elevations from May through Oct.	Lake Pend Oreille water levels are generally raised from May to Jul and then held constant until Sep and drop rapidly through Oct. Current operations maintain lake levels that support spawning/rearing habitat until for northern pike.	No difference from NAA.	No difference from NAA.	No difference from NAA.	On dry years, under MO4 Lake Pend Oreille may be as much as 2.5 feet lower in Jun through Sep compared to NAA. Under these conditions, the team expects there to be a decrease in suitable habitat for northern pikeminnow.	In Clark Fork River above lake, expanding. Pike are present, Rocky Mountain Research station looking at pike distribution patterns. Entrainment from upstream and in-lake recruitments. Carim, 2019.
Flow regime could affect entrainment rates into Lake Pend Oreille from Clark Fork River. High flow rates could move fish from Noxon Rapids and Cabinet Gorge Dams.	Flows from Cabinet Gorge Dam during spring freshet (May and June).	High flow in May and Jun. Higher flows result in increased risk of entrainment. Median flow = 48,392 cfs. Entrainment most common May to Jun when flows are high.	Median flow = 47,818 cfs ~ 1.2%. No difference from NAA.	Median flow = 47,296 cfs ~ 2.4%. May be slight reduction in risk of entrainment under MO2.	Median flow = 47,727 cfs ~ 1.4%. No difference from NAA.	Median flow = 47,858 cfs ~ 1.1%. No difference from NAA.	Need more information about this relationship and citations.
Downstream of Albeni Falls							
Northern pike suppression program POR-program uses netting and angling to remove non-native northern pike.	Northern pike removal.	Current northern pike suppression has removed 17,193 northern pike from 2012 through 2018. Catch rates have dropped dramatically in recent years. Current management is single greatest effect to northern pike populations. Program will continue to suppress northern pike populations.	No difference from NAA.	No difference from NAA.	No difference from NAA.	No difference from NAA.	Need removal numbers or rates.
Native Fish Community							
Pikeminnow are part of native fish tab – they are a minor player here, but part of the native fish community. Not a relationship – just a statement of current conditions.	Northern pikeminnow numbers.	Reduced numbers of northern pikeminnow.	No difference from NAA.	No difference from NAA.	No difference from NAA.	–	Because northern pike minnow are not a decision driver in this basin they will not be discussed further.
Mountain whitefish – Flows in winter spawning season could affect spawning below Albeni Falls Dam. Dewatering eggs could be an issue.	Outflows at Albeni Falls during spawning and incubation (Oct to Apr 15).	Mean flows drop from ~24 kcfs in Oct to 19 kcfs in Nov and 14 kcfs in Dec when eggs are still in the nest incubating (reduction in flow of 42%). Under the NAA mountain whitefish eggs will be dewatered below Albeni Falls Dam.	No difference from NAA.	No difference from NAA.	No difference from NAA.	No difference from NAA.	Spawn in tailraces of Albeni Falls, Box Canyon, and Boundary Dams. Oct to Nov. Hatch out between Dec and Jan. Broadcast spawn, gravel/cobble, and adhesive eggs.

Affected Environment Important Relationships/Criteria	Affected Environment Metric	Environmental Consequences NAA	Environmental Consequences MO1	Environmental Consequences MO2	Environmental Consequences MO3	Environmental Consequences MO4	Notes
Predation from non-native predators impact native species (sucker and minnow – see effects to kokanee).	Predator numbers.	Additional non-native predators include walleye, smallmouth bass, northern pikeminnow, and lake trout. Increased number of non-native predators is likely to alter native fish community.	No difference from NAA.	No difference from NAA.	No difference from NAA.	No difference from NAA.	–
Invasive milfoil alters native species habitats. Lake elevation fluctuations can lead to milfoil reductions.	Milfoil expansion – pool elevation fluctuations at Lake Pend Oreille.	Milfoil in the Pend Oreille River in 1982. Annual pool elevations will fluctuate 11 feet at Lake Pend Oreille with peak elevations in the summer of 2062 to a low in winter of 2051. Pool fluctuations of 11 feet will limit expansion of milfoil in shallow water (top 11 feet) of Lake Pend Oreille. Expansion may occur outside this band. Limitation of northern pike and yellow perch habitat.	No difference from NAA.	No difference from NAA.	No difference from NAA.	On dry years, Lake Pend Oreille will not reach full pool ~ 2.5 feet below full. This will not change the effect to milfoil. Still reduced expansion in top 11 feet of reservoir.	Milfoil invasion likely caused and/or exacerbated by dams.
Game Fish Largemouth Bass, Yellow Perch, and CRP							
Warmwater fish spawning/incubation and water elevation – water level fluctuations, especially dramatic drops will lead to desiccation of eggs or fry. Water level for Jun and Jul.	Water elevations (Jun and Jul).	Water elevations in Lake Pend Oreille are rising slightly or held constant in Jun and Jul. Water elevations will continue to support warmwater game fish spawning and incubation. No effect.	No difference from NAA.	No difference from NAA.	No difference from NAA.	On dry years, water levels will not reach full pool under MO4, but will be up to 2.5 feet below full pool. No fluctuations are anticipated during the spawning and incubation period of warmwater game fish.	–
Winter drawdown of the lake interrupts juvenile rearing and may reduce numbers of non-native species like tench, largemouth bass, pumpkinseed, and black crappie compared to the population size that would exist if there was no winter drawdown of the Pend Oreille River above Albeni Falls Dam (Joe Dupont and Dave Bennett, 1983).	Water elevations from Oct through May at all three waters.	–	No difference from NAA.	No difference from NAA.	No difference from NAA.	No difference from NAA.	–

Affected Environment Important Relationships/Criteria	Affected Environment Metric	Environmental Consequences NAA	Environmental Consequences MO1	Environmental Consequences MO2	Environmental Consequences MO3	Environmental Consequences MO4	Notes
Gerrard (Kamloops) rainbow trout are an important trophy sportfishery at PDR Basin. Suggest using the same relationships as for bull trout and kokanee.	Kokanee numbers.	–	No difference from NAA.	No difference from NAA.	No difference from NAA.	No difference from NAA.	Kokanee populations are key prey item for this predator species. Potentially tributary mouth issues – spawn in spring on rising hydrographs. Spring fishery in Clark Fork and Pack Rivers. Current operations appear to support populations. See Affected Environment for discussion. Natural reproduction is good. Andy Dux, 2019.
Below Albeni Falls Dam – mostly warmwater species, including bass and panfish. There are increasing numbers of walleye.	Water temperatures below Lake Pend Oreille.	–	No difference from NAA.	No difference from NAA.	No difference from NAA.	No difference from NAA.	Walleye expansion commensurate with Lake Pend Oreille increases.
Brown trout population in Box Canyon and Boundary Reservoirs, most temperatures tolerant of salmonids, but still limited by temperatures.	Summer temperatures (Jun to Sep).	Temperatures go from 16°C in Jun to 24°C in Jul and Aug, then back to around 15°C in Sep. Summer water temperatures below Albeni Falls Dam will continue to be limiting for coldwater fish species in the NAA.	No difference from NAA.	No difference from NAA.	No difference from NAA.	No difference from NAA.	Water Quality Appendix 7-3. Raleigh et al., 1986.
Notes on burbot. Not on the species list for this area, but checking around there are a couple of burbot populations in lakes in the basin, draining in to the Pend Oreille River below Albeni Falls Dam, but they were introduced. Genetically linked to Kootenai stock. Not in scope of EIS.	–	–	–	–	–	–	–

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3.8.2 Region B

3.8.2.1 Lake Roosevelt/Columbia River from Canadian Border to Chief Joseph Dam

Fish and aquatic resources in this basin were evaluated qualitatively. Hydrology and WQ data outputs from models were examined to predict effects using relationships between these parameters and biological responses. These relationships were guided by conceptual ecological models for species in this area and regional/local knowledge of the subteam. These relationships and the effects were developed in a series of workshops in Spokane, WA as well as followup conference calls and other collaboration. Retention time was found to be an important relationship to many resources in Lake Roosevelt, so additional processing of hydrology data was requested to provide this metric. Tables and a hydrograph illustrating how retention time would change under each alternative are provided here. Although the entrainment and growth relationships apply to many species in the reservoir, much of the existing literature focuses on kokanee, so the retention time analyses is documented in the kokanee spreadsheet and referenced in other species where applicable. Another data need was to understand how water quality may change in specific locations where there are net pens for mitigation fish rearing. The water quality team provided additional analyses and tables showing that data are also provided in this appendix.

Table 3-75. Columbia River, Canadian Border to Chief Joseph Dam, Qualitative Effects Analysis Matrix

Affected Environment Important Relationships/Criteria	Metric	Environmental Consequences NAA	Environmental Consequences MO1	Environmental Consequences MO2	Environmental Consequences MO3	Environmental Consequences MO4	Notes
Bull Trout							
Use of Columbia River Reach as Feeding, Migratory, and Overwintering (FMO) Habitat							
Key issues: Very few. FMO only, isolated from spawning habitat. Temperatures and flows could slightly affect distribution, timing through entrainment, and flushing downstream into FDR and entrainment into Lake Rufus Woods. Bull trout prey base could be affected by productivity influenced by retention time of water in the reservoir.							
Temperatures greater than 18°C result in stress; mainstem in FMO habitat only. Bull trout leave when temperatures get higher.	Temperatures: Mainstem Columbia and Lake Roosevelt	Temperatures continue to support the few bull trout that use this reach.	No change in temperatures.	Same as NAA.	Same as NAA.	Same as NAA.	Max about 18°C is within criteria for bull trout.

Affected Environment Important Relationships/Criteria	Metric	Environmental Consequences NAA				Environmental Consequences MO1				Environmental Consequences MO2	Environmental Consequences MO3	Environmental Consequences MO4				Notes	
High flows in spring during high flow years result in increased flow (spring) could increase recruitment from river reach into FDR.	GC inflow peak and duration									Similar to MO1. Negligible effect to flushing bull trout into the reservoir.	Similar to MO1. Negligible effect to flushing bull trout into the reservoir.					After 97 high flow, started seeing some bull trout in reservoir. CHJ kokanee enhancement project. Lake Roosevelt data collection project. (BPA projects), unpublished data. (1990 to 2000 era). *Note: MO1 and MO4 workshop did not have wet/dry/ave hydrographs, so used calculation of HH data. MO2/MO3 workshop was later in process and hydrographs were available to visualize alternative compared to NAA without having to do calculations. In MO1 to MO4, should not have averaged monthly means, but the conclusion is the same.	
			1%	25%			1%	25%	50%				25%	50%	75%		
		May	256775	84479	15	May	254999	180432	148			May Mean Mon	180309	148055	12		
		Jun	323726	16408	17	Jun	320853	212547	175			Jun Mean Mon	213188	176495	13		
		Comb:	290250	200443	16	Comb:	287926	196490	161			*Ave May / Jun	196750	162275	13		
		Peak:	359328	244681	20	cfs chg:	-2324	-3954	-48			cfs chg	-3995	-4520	-4		
		High flow years would continue to potentially flush to FDR in high water events. Could be increased entrainment into Lake Rufus Woods.				Pct chg:	-0.8%	-2.0%	-2.			Pct chg	-1.8%	-2.7%	-3		
						Peak:	356197	240864	203			Peak	356331	240342	20		
						Peak chg:	-3131	-3817	-45			Peak Chg	-2997	-4339	4		
						Pct chg:	-0.8%	-1.6%	-2.			Pct chg	-0.8%	-1.7%	-2		
						No change in duration. Negligible effect to flushing bull trout into the reservoir.						No change in duration. Negligible effect to flushing bull trout into the reservoir.					
Water quality/sediment effects: Increased reservoir fluctuations could increase redox of mercury. Contaminants could affect bull trout adults, bioaccumulation (top predator).	Reservoir fluctuation events, elevation profiles	Current rates of redox events would continue; baseline rate of bioaccumulation.				Pool elevations are generally lower Dec to Feb, but does not appear to have additional fluctuation events at the 25/50/75 percentile; potentially more fluctuations in extreme conditions (1%). Lower elevations in Dec to Mar could increase potential for exposure, but fluctuations (daily) would be similar to NAA. Likely no measurable effect to bull trout. About 5 feet more increased sediment exposed could increase mercury in the system in fall. All MO Alts: 1,2,4 - winter frm = more risk in Dec and Jan.				Similar to MO1. MO2 - deeper draft in Jan All earlier draft (.8SRD) Jan/Feb in wet years, MO2 - Sep lower All MO Alts: 1,2,4 - winter frm = more risk in Dec and Jan	Same as NAA. MO3 - slightly reduced risk in Jan (less draft)	Dry years: More variability than NAA, also deeper draft. Dry years have highest potential for effects, drawdowns up to 22 feet from NAA. All MO Alts: 1, 2, 4 - winter frm = more risk in Dec and Jan Mitigation: Do follow-up mercury analysis (fish tissues) to update human health advisory. Current advisory may become outdated if changes in redox events. Fish with highest risk are walleye, pike. If high risk to human health - provide replacement species for harvest. (move this from bull trout tab to other spp.)				See meeting notes from WQ to determine mechanism for redox events. See Elevation profiles. Drawdown at forebay results in exposure of upper reservoir exposed shoreline extent. Look at March-May. Ongoing tissue monitoring - tie to mercury methylation. Increased mercury methylation and bioaccumulation (see Willacker 2016, Reservoirs and Water Management Influence Fish Mercury Concentrations in the Western United States and Canada). Relationship is from literature, Likely more concentrations in lower parts; but with mercury it may not necessarily be the case, in water. Juvenile more susceptible? Timing - in December less actively feeding. Inundation in Jan to March, could introduce mercury into the food web. Willacker, 2016 Eagles-Smith, 2016	

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Lake Roosevelt Operations effects on bull trout as FMO							
Lake Roosevelt temperatures.	Lake Roosevelt Temperatures – 5-year water quality in the reservoir.	–	Negligible change to temperatures in 5-year reservoir results.	Likely same as NAA.	Likely same as NAA.	Likely same as NAA.	Temps may get too warm, very few bull trout in FDR, can move to cool areas, DO stays good. If in Spokane arm, may move out if DO/temperatures limit. See kokanee page....determining model result of less stratification reducing cold-water refugia. Volume-weighted temp at Kettle Falls. Note - not relevant to bull trout necessarily, but general... Temps using volume-weighted averages. Near dam temps may be more difference. Anoxia does occur upstream of Spokane arm, model vertical profile. Spokane has DO data. Can provide DO profiles in Spokane arm to see if model captures biological implications.
Lake Roosevelt prey base.	Prey population effects – primarily entrainment.	–	See kokanee tab.	See kokanee tab.	See kokanee tab.	See kokanee tab.	Retention time relationship to kokanee entrainment applies to bull trout as well. As forage fish are concentrated more towards the dam, bull trout would be too.
High flow – higher entrainment out of FDR, moves bull trout downstream, eventual fate not known. Mortality may move on downstream to other areas.	GC outflow.	–	Dec outflows 2%-6% higher Apr-Sept 2%-5% lower Average of mean monthly flows = 106258, -1.8% Generally the same or slightly higher in Oct/Nov, 2-8% higher in Dec/Jan, 2-5% lower in Mar-Apr. Increased median outflows in December = 100,525. Likely immeasurable change, increased outflows could potentially increase entrainment risk in December and decrease risk in Mar-Apr/December outflows, Most bull trout in upriver? But some near Sanpoil, potential for bull trout near dam.	Nov, Dec higher outflows (Nov 2%-5% and Dec 8%-15% higher). Sept. 4% higher. Oct. 8%-9% lower. Mar-May slightly lower, Jun-Aug similar to NAA. Higher outflows in Nov, Dec, and Feb could increase entrainment out of FDR.	–	Average of mean monthly flows = 106258, -1.8% Generally - slightly lower in July/Aug, 3% to 17% lower in Sept to Oct, slightly higher (0% to 3%) in Dec/Jan, (0% to 9%) lower in Feb to Apr, mixed in May to Jun (higher in low water conditions, lower in high water conditions). Increased outflows in dry years in Jan and May could increase entrainment risk. Bull trout prey species typically moving towards the dam to follow zooplankton, bull trout follow this food sources and become more susceptible to entrainment, and higher flows increases entrainment risk as well. High fluctuations in Nov to Jan - could smooth those out?	Beeman et al., 2003, LeClaire, 2000 Entrainment in high flow years. When catch some in one year, typically don't catch any the following 2 years. Entrainment out of drum gates not by composition. (For rainbow, when elevation drops below 1260, entrainment increases)
Lake Rufus Woods as FMO – negligible. Did not analyze effects to bull trout in Lake Rufus Woods.	–	–	–	–	–	–	–

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White Sturgeon							
Recruitment as a function of flow >200 kcfs, at 14°C for 3 to 4 weeks in late Jun/beginning of Jul, coupled with lower reservoir elevations low enough to provide riverine stretch.	GC Elevation, Columbia at Border flow – number of days exceeding 200 kcfs, Jun 15 to Jul 31. Temperature at border.	Apply to No Action alternative HH and water quality outputs to determine how many out of POR would provide these conditions. Days exceeding 200 kcfs Jun 15 to Jul 31 1% = 43 days 25% = 8 days 50% = 0 70.1% chance exceedance 200 kcfs Apr 1 to Jul 31. Discharge duration: About 36% of the time June discharge exceeds 200 kcfs; about 10% July. Conditions typically not conducive to successful recruitment except in very few water years. In 3 years since 1995.	Days exceeding 200kcfs 1% = 42 days 25% = 3 days 50% = 0 days 53% chance exceed 200kcfs Apr 1 to Jul 31 Discharge duration - about 25% of the time exceeds 200 kcfs in Jun, about 8% in Jul. About 2% lower discharge duration, about 5% lower chance of exceeding this discharge in Jun/Jul, and one or two fewer days where discharge exceeds 200 kcfs. This would be a small decrease in potential recruitment window for white sturgeon.	June 15-July 31 flows are similar to MO1 Days exceeding 200 Kcfs 1% = 43 25% = 2 50% = 0 52% chance exceedance Apr1-Jul31 Same as MO1	Same as MO1 and MO2, slight decrease from NAA, likely imperceptible.	Days exceeding 200kcfs 1% = 42 days 25% = 4 days 50% = 0 days 53% chance exceeding 200kcfs April 1-July 31 Discharge duration - about 25% of the time exceeds 200kcfs June, About 8% in July. Same as MO1 in high and average years. Increased flows compared to NAA in low water years, but no change to sturgeon recruitment. Low years don't get enough flow in any scenario for recruitment.	Sturgeon annual reports (Colville and McLellelan and Howell). Use mid-June ok because temps likely don't meet criteria until about then. Flows used to get there more often until mid-60's, but modeling incorporates today's configuration (operating rules) on past hydrology record. Spokane 1995-02700 96-97, 2011 had recruitment documented. High water years get some recruitment. Successful spawning, YOY every year, but fail after larval stage. Potential mitigation for any sturgeon recruitment failure: larval transport, capture wild-caught larvae and transport to habitats in reservoir (skip over the transition zone, hypothesis of issues there = contaminants, predation, etc.).
Reservoir elevations lower, in late Jun to early Jul increases chances of recruitment.	GC Elevation, Jun 30 and Jul15 elev. In high water years	Jun 30 = 1285.2 July 15 = 1289.5 Reservoir influence above China Bend at full pool. Compare where river conditions transition to reservoir. Sturgeon survival model looked at 1210-1290. Drawdown to Kettle area would increase recruitment.	Generally 0.0 to 0.3 feet lower in June and July at most exceedances. Jun 30 = 1285.1 Jul 15 = 1289.5 Slightly lower or no change in most conditions. Potentially increased riverine habitat to offset decrease in flow from first relationship. Most substantial change (decrease of 1.3 and 3.8 feet, is in 98 and 99 percentile exceedances, respectively (already low conditions).	Jun 30 = 1285.3 (+0.2') Jul 15 = 1289.5 Same as NAA	Jun 30 = 1285.1 Jul 15 = 1289.5 Same as NAA	Ave and wet years: Jun 30 = 1285.1 Jul 15 = 1289.5 Dry years: median in dry years about 22 feet lower from comparison plots) 40% of years, 5 feet lower than NAA 30% 15' lower 20% 24' lower (from exceedance curves) Lower lake levels when already low conditions. Any benefit? Slightly lower at the higher exceedances would be benefit for sturgeon. In dry years, lower elevations potentially improves conditions, by providing additional length of riverine habitat for larval dispersal and increases probability for recruitment, but unlikely to have flows to provide any spawning/recruitment.	Use 80 year set, wet/ave/dry years of flow data overlaid with elevation data. Assume temp is the same. CCT has sturgeon recruitment and hydrology modeling report. Sturgeon go to same spot for spawning. Same temps at boundary. H&H? To figure additional river miles; is there a lag between dry year elevations and wet year inflows? A: No, GC resets.

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Productivity/food effects on larvae – unknown (see flow correlation). See kokanee tab for food web, productivity effects. Note: indirect relationship to phytoplankton/zooplankton and food likely not limiting.	Retention time related to entrainment of food organisms	See kokanee tab. Larval sturgeon likely feeding on benthic organisms. Potential indirect relationship to retention time - zooplankton – filter feeding benthos; food likely not limiting.	Retention time - see Kokanee. Minor changes in flow, likely no effect.	Retention time - see Kokanee. Likely not affecting sturgeon - see notes.	Retention time - see Kokanee. Likely not affecting sturgeon - see notes	See kokanee tab. Retention time - see Kokanee Likely a minor effect on sturgeon, they are in part of reservoir where not a lot of zooplankton, not pelagic like kokanee. Food limitation Is not the concern for sturgeon. Also, the contamination, predation, and lack of riverine habitat to recruit.	See retention time discussion in kokanee? Relative to white sturgeon - same source? Is the same relationship of reservoir rearing below? Or different nuance in river? Larvae are in system in mid-July, then removed for hatchery program. Ones left in the system likely do not survive. Sturgeon are all up in upper Region, inflows not changing enough to affect food dynamics.
Predation (smallmouth bass/walleye) on larval sturgeon. Reservoir conditions favor predators; see predator; inflows can flush larvae into reservoir conditions.	–	See smallmouth bass and walleye tabs.	Flows similar to NAA, slightly lower. Slightly lower inflows, potentially lower risk of moving larvae down.	See smallmouth bass and walleye tabs.	–	See smallmouth bass and walleye tabs. Dry years, longer reaches of riverine habitat, less predation risk, predators would move to reservoir.	Slight change to inflows, unlikely to see biological effect. See smallmouth bass and walleye tabs. Predation is a suspected limiting factor for sturgeon.
Contaminants: Closer to Canadian border, increased copper. Copper has sublethal effects on sturgeon swimming behavior, feeding, predator avoidance, etc. Higher flows move larvae further downstream and into lower copper concentrations. Cadmium is more widely dispersed.	Flow at border	Flows at current level would continue to mobilize contaminants further downstream at the rate similar to in the past.	Slightly lower in Dec, slightly higher in Jan/Feb. Potential increase in movement of contaminants from above Kettle Falls area into the mid and lower River.	Inflows slightly higher in Nov/Dec. Same as MO1, slightly higher magnitude.	Same as MO2.	June/July inflows higher in low water years (McNary measure triggered). More potential for moving larvae down, but in low water years (when measure is triggered), there are likely no larvae there. Contaminants could be mobilized downstream more than in the NAA, but no effect to sturgeon.	Additional flows could move larvae out, but could also increase transport of contaminants further down too. Slight changes to inflows among alternatives.
Subyearlings (hatchery) through adults reach very high survival once around 200 g (about 12 inches). Reservoir conditions provide adequate rearing conditions.		Reservoir would continue to provide good conditions for growth and survival of sub-yearling through adult life stages.	NA	See change descriptions, see any effects to subyearlings? No change.	See change comparison, see any effects to subyearlings? No change.	See change comparison. Potential change in reservoir v. riverine conditions, but likely would not change suitability for sturgeon grown and survival after they reach about 200g.	Note: effects not noted, but keep this row for notes. Talk through reservoir spp. Any effects to conditions for reservoir rearing for subyearlings to adults?
Temperatures – adults require 12°C to 14°C.	Reservoir temp	No change in any alts noted.	No change in MO1 data. Same as NAA.	Same as NAA.	Same as NAA.	Same as NAA.	Hanson et al., 1992. No change to temp in any alts. Keep this row for notes.
Contaminants: Adults feed in reservoir and may bioaccumulate mercury (see bull trout page). Keep this line for notes only specific to sturgeon.		See bull trout tab.	See bull trout tab.	See bull trout tab.	See bull trout tab.	See bull trout tab. Higher variability and deeper draft could increase redox events.	Fishery 38 inches to 62 inches for tribes and 54 inches to 62 inches for state anglers. Hatchery fish, were stocked as subyearlings, growth to "take" size would be about 10 years in mercury exposure.
Burbot							
Columbia River							
Columbia River elevations relate to depth needed to support	Water surface elevations; Feb to Mar drops in	River conditions under the NAA provide adequate depth for burbot.	March about 2 feet to 3 feet lower than NAA. Potential reduced habitat and increased	MO2 wet years, draw down lower and a little faster (5 feet lower on Mar 1). Potential	Same as NAA.	Same as MO1.	See profiles map - determine best cross section to look at. Reach 720.431. NOTE: need drop in Feb to Mar data.

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burbot, and drops in river stage in Feb to Mar can dewater eggs.	elevation at RM 720.431.		stranding of eggs compared to NAA.	reduced habitat and increased stranding of eggs compared to NAA. Slightly higher magnitude than MO1.			
Cold temperatures (see kokanee page for potential change in reservoir stratification), likely modeling artifact.	Temperature in river	See kokanee tab, line 11.	No change in river. Reservoir? See kokanee tab, line 11.	See kokanee tab, line 11.	See kokanee tab, line 11.	See kokanee tab, line 11.	No change expected from any alts. Bonar et al., 2000
Velocities in river can affect suitability for burbot spawning (need slower velocities in winter).	GC Inflows Dec-Mar	See notes.	See notes.	See notes.	See notes.	See notes.	No velocity data; no notable changes expected in inflows that would change velocities that would be biologically notable. Retain line for records. Bonar et al., 2000.
Lake Roosevelt							
Drawdowns in Lake Roosevelt elevations in winter/early spring can dewater eggs.	Use elevation comparison, visualize and estimate drop from Dec to end of Mar.	Reservoir elevations comparison. Ave years about 20-foot drop from Feb 1 to end of Mar. Dry years, only about 3-foot drop while in gravel. Wet, dry years - 30-foot drop in Mar. Reservoir spawners likely high loss of eggs; river spawners not as affected.	Deeper drawdowns Dec to Mar. See elevation comparisons. Dec to Mar drawdowns could potentially dewater eggs. Rate of change of reservoir elevations is the same. Habitat use not well-known, but Dec to Mar drawdown would decrease availability of habitat overall. Slightly less steep drawdown would decrease (slightly) risk of dewatering. In terms of slope, could be beneficial; terms of habitat, it's a data gap.	Deeper and steeper drawdowns than MO1 Similar effect to MO1 with higher magnitude in dry years.	Same as NAA	About 10-foot deeper drawdowns in Dec to Feb or Mar. Likely to strand/ desiccate more eggs in dry years than NAA. Wet and average years continue to experience high loss of eggs similar to NAA. Early spawners affected by additional drop in Jan.	Spawn near Colville River on shorelines, winter Feb to Mar, FRM year, drafting a lot increases chance of this effect. Juveniles hatch, feed on zooplankton, exacerbates effects. Very shallow spawners, any drawdown in Feb to Mar timeframe can desiccate eggs. Lower surface elevations from wildlife map. Look at summary hydrographs for drawdown events.
Retention time affects direct entrainment of burbot. Food availability prey base for juveniles, food source is pushed further down-reservoir by flows. Burbot follow the food source and can become more susceptible to entrainment.	Retention time, see kokanee tab	See kokanee tab.	See kokanee tab. Slightly lower retention times (2-3 days) in Dec-Mar could increase risk of burbot entrainment. See also kokanee tab.	See kokanee tab. Lower retention times (up to 6 days) in Dec to Mar could increase entrainment risk for burbot during spawning season.	See kokanee tab Similar to NAA; slight increase in retention time potentially increases food and lessens potential entrainment.	See kokanee tab.	Pelagic species; (link to other pelagic species). Decreasing retention time leads to increasing entrainment. Retention time metric, how calculate? Flow routing could affect how fast zooplankton get pushed out, but use retention time. Retention time is of inflow/outflow. See notes on retention time, developed by H&H.
Retention time of water through the reservoir effects food availability and location. Higher retention time = more food and more widely dispersed. Lower retention time = less food available and higher concentrations of zooplankton further down-reservoir.	See above.	See kokanee tab.	See kokanee tab. Slightly lower retention times (2 to 3 days) in Dec-Mar could reduce food supply for burbot during spawning season.	See kokanee tab. Lower retention times (up to 6 days) in Dec to Mar could reduce food supply for burbot during spawning season.	See kokanee tab. Similar to NAA; slight increase in retention time potentially increases food.	See kokanee tab	Plankton size - larger plankton vs smaller smaller. Larger-bodied daphnia have longer generation times (higher flows-source popn move further downstream), longer retention time allows more to mature before washing out of reservoir. May shift the prey availability from larger to smaller plankton, potentially exacerbating the entrainment issue. Winter spawning season critical time for feeding?

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Kokanee							
Retention time and Food Supply: Retention time of water through the reservoir effects food availability and location. Higher retention time = more food and more widely dispersed. Lower retention time = less food available and higher concentrations of zooplankton further down-reservoir.	Retention time-year round	See RT file. Generally 40 to 50 days in winter/spring, downs to 21 days by June, gradual increase over summer to 45 days end of Aug. Sept and Oct 60 to 80 days. The NAA regime of retention time supports the current fish community. Kokanee, redband rainbow trout, juvenile burbot, larval sturgeon, and many prey species rely directly. Bull trout indirectly.	See graph Oct to Nov: = NAA Dec Ave: 45 Dec (-7%) Jan: 2 to 4 days <NAA (-7% to 10%) Feb: Wet and Dry 2 to 3 days <NAA, Ave: = -4% to 5% Mar: Wet 1day <NAA, Dry 1day >NAA, Ave: = Apr to Sep: Similar to NAA Losses in primary/secondary production, source populations get moved downstream, draws fish closer to the dam outlets. (Dec. FRM measure) Lesser retention times are not as critical because RT is higher (lower percentage change). Some loss of food supply. Increased outflows starting in Dec, increased drawdown.	Similar to MO1: Oct-Nov: = NAA Dec: Ave: 42 days, 6d <NAA (MO1 was 2 to 4 days <NAA) -14% Jan: 2 to 4 days <NAA (-7% to 10%) Feb: Wet and Dry 2 to 3 days <NAA, Ave: = Mar: Wet 1 day <NAA, Dry 1 day >NAA, Ave: = Apr to Aug: Similar to NAA except May 1 to 15: 3 days >NAA Sep: 3 days <NAA Similar to MO1 but larger magnitude of effect in Dec. 13% decrease in retention time. Decrease in food source in winter. Increased in summer (2% to 6% higher). Deeper draft for hydropower would be a larger magnitude of impact. Retention time, elevations, outflows effects are masked by winter FRM measure in this case.	Similar to MO1 except 2 to 3 days >NAA in Jan. Average years (MO1 is <NAA in Jan). Similar to MO1, but slightly less effect in Jan. Note: Change is in Jan and NAA is about 45 days, is 2 to 3 days either way make a difference?	Average and Wet Years: Same as NAA except: 2 to 4 days <NAA in Dec-Jan and mid-Jun through Aug. Dry: 5 to 8 days <NAA in May to Aug, as low as 25 days for much of May; about 5 days >NAA in Sep; Dec and Jan up to 8 days <NAA, as low as 40 days in Dec and Jan. Median and below water years would see retention time reduced, leading to reduced food availability. Likely affect growth in kokanee negatively. Would result in smaller plankton. Shift to smaller plankton size would decrease food value for kokanee (they feed on larger ones). Drawdowns for longer periods, larger relative volumes of water are going to be warm, ex: in tributaries such as Spokane arm, effect to juvenile fish that use these habitats. In MO4, Sept and Oct retention time is higher than NAA, slightly positive effect on retaining fall and winter food source. The dry year scenario is more likely to be more frequent in the future due to climate change. (Modeled as outliers but likely to become more frequent.) Fall flows/lower retention time flushes out winter food supply. Elevation also important for spawning. Temperature discussion, temperatures do not get too warm for kokanee now, but would reduce retention time lead to temp issues? Spikes in retention time in model in 95 percentile are likely indicative of reaching draft	See workshop notes. LeClaire 2000. Bret to send. Baldwin and Polacek 2002- evaluating limiting factors. Plankton size - larger plankton vs smaller. Larger-bodied daphnia have longer generation times (higher flows-source popn move further downstream), longer retention time allows more to mature before washing out of reservoir. May shift the prey availability from larger to smaller plankton. Potentially exacerbating the entrainment issue. Adult kokanee looking for one thing, juveniles another. Kokanee are size selective on plankton. Fall zooplankton ds, but kokanee probably dispersing to spawning habitats. Team: Is change in RT more important when RT is already low? Is a percentage change meaningful? Yes, use percent change. Difference less critical at higher rt. Are there other factors that make difference in importance of retention time? Hatchery or wild? Most kokanee are wild, but there is a hatchery component. Ecosystem benefits for wild would be same for hatchery except for spawning considerations.

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						target in Oct then shutting down outflows.	
Retention time and Entrainment: Decreased Retention time and increased outflows tend to move the concentration of plankton nearer to the outlets. Kokanee follow the food source and become more susceptible to entrainment. Note - several factors increase risk: elevation, retention time, and habitat use.	Retention time and outflows	See RT file, and summarized above. 10-13% of pelagic fish lost each month to entrainment. Kokanee follow the food source and concentrate in the lower reservoir where they are more susceptible to entrainment, lost from FDR population. Over 400,000 average entrained fish per year, (LeClaire, 2000), 30% to 50% kokanee, primarily wild. Redband rainbox second most.	See Row 7 for RT Monthly Average. Potentially increased entrainment in Dec-Jan, Feb. and April. See notes on elevation. Drawdown initiated sooner in Dec, 7% to 10% decreased retention time could prolong the time period when fish are more susceptible to entrainment. Potentially increase entrainment 7% to 10%, Earlier draft would increase entrainment. Flat spot measure, in 5% to 6% of years the elevations would be up to 8 feet lower than NAA in April. Could increase entrainment risk to kokanee. Flat spot measure, in 5% to 6% of years the elevations would be up to 8 feet lower than NAA in April. Could increase entrainment risk. . Winter space masks 0.8 feet per day drat rate in wetter years. Already lower in Jan from winter space, so don't see draft rate impacts on outflow/elevations. Without winter space, .8SRD would draft earlier (Jan and Feb), compared to March/Apr in NAA.	See Row 7 for RT Monthly Ave. Same as MO1, but larger magnitude of effect in Dec.	See Row 7 for RT Monthly Ave. Entrainment similar to NAA, potentially less entrainment than NAA in Jan.	See Row 7 for RT Monthly Ave. and see also game fish tab for discussion on retention time/entrainment. Decreased retention time in Dec-Jan would increase kokanee entrainment. Elevation also exacerbates entrainment. Decreased retention time would concentrate kokanee near the dam, and elevation. Dry years increased entrainment in summer. Increased outflows in winter months would be more susceptible to entrainment, because they follow the food source. Plankton food source pushed downward to nearer the outlets. Retention time would decrease correspondingly. Mitigation - fish collection system near forebay of GC to trap, sort, and transport native spp. Elevations below 1260 causes increased entrainment. 400,000 fish annually or more. Daphnia source entrained.	Entrainment accounts for up to 30% total limnetic fishes (study on hatchery fish limiting factors) Baldwin - correlated inflow to entrainment rates. Powerhouse intakes are near regulating outlets, does reservoir elevations coinciding with times of short retention times affect entrainment rates (i.e., kokanee at a certain point in the water column, where they are can be affected by lake elevations). See game fish tab: elevation affects correlation for net pen fish.
Elevations lower than 1283 can result in reduced access to tributary habitat compared to the NAA.	Reservoir elevation	All water years meet 1283 by 9/30. Access issues would remain as in past. Historical target, there could be issues under the NAA but not known.	See Elevation Forecast Comparisons All water years above 1283 feet by 9/30. Same as NAA.	Wet and average years above 1283 feet by 9/30. Dry years only to 1279 feet by 9/30. Potentially access issues in dry years.	All water years reach 1283 feet by 9/30. Same as NAA.	In wet years, both NAA and MO4 are typically above 1283 feet in Sep through Jan. In median water years and below. MO4 drops below 1283 feet (20 feet below) about Dec. 1 and stays below through Jan. Tributary access would be impeded by drops in reservoir elevation in December; predation (avian) risk could increase and volitional migration time could increase. Increased exposure to varial zone issues. Similar to MO2, but higher magnitude.	1283 feet is an operational metric. By Sep 30 at 1283. Sep is peak run for kokanee/native fish. Small part of population uses tributaries; more relative to rainbow. Kokanee are primarily shoreline, but redband are tributaries only, so redband would be more affected by this effect. Keep this relationship for kokanee, but is not a high magnitude. Only applies to the portion that use the tributaries. Mitigation: study access to tributaries. Survey elevations, determine if access impeded, varial zone issues, etc. Identify and resolve where effects are determined.

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Affected Environment Important Relationships/Criteria	Metric	Environmental Consequences NAA	Environmental Consequences MO1	Environmental Consequences MO2	Environmental Consequences MO3	Environmental Consequences MO4	Notes
						See also redband tab, same relationship.	
If reservoir levels decrease after spawning, eggs can be desiccated.	GC elevation Sep to Feb. Elev_Fcst_ comparisons, see figure below.	Wet - steady or rising Sept to Feb, drop to 1267 feet in March. Average: 1288 feet (Jan 1) to 1285 feet (Feb 1), 3-foot drop (steady Sept 30 to Jan 1), 18-foot drop Feb 1 to 28 to 1267 feet. Dry: Drops from 1288 feet (mid-Nov) to 1281 feet (Feb 1). 7-foot drop, but then rising in Feb 1 to 28. Wet years: Reservoir elevations typically rise gradually after kokanee spawn ok, until Feb when drops 20'. Ave years: 3-foot drop could desiccate eggs in shallow spawners, fry also stay in gravels and could get stranded. Dry: same issue, more kokanee affected; likely direct relationship to drop.	Wet: 1288 feet (Dec 1) to 1278.5 feet (Feb 1), 9.5-foot drop, compared to no drop in NAA. Ave: 1288 feet (Dec 1) to 1282 feet (Feb 1) 6-foot drop compared to 3-foot drop in NAA, and drops 1 month earlier Dry: Drops from 1288 feet (mid-Nov) to 1276 feet (Feb 1). 12-foot drop, 5 feet more than NAA. Wet years: 9.5 feet more drop Ave: earlier timing of drawdown would put more kokanee at risk (none hatched out yet); Dry: Follow the data.	All water years drop 1288 feet (Dec 1) to 1279.5 feet (Feb 1), 8.5-foot drop compared to no drop in wet, 3-foot drop to 7-foot drop in dry years in NAA. All years effect would be similar to MO1. but with different magnitude (figure % change to show relative) In dry years; kokanee would likely spawn at lower elevations than under average and wet; so the following drop in December would not affect those eggs until it drops below 1279 feet.	Wet and Ave years: steady or rising Sep 30 to Feb. 1. Note - flat spot holds ave a little higher longer to keep from dropping until after Feb. 1, as compared to NAA. Dry: Drop 1288 feet (Dec 1) to 1284.75 feet (Feb. 1). 3.25-foot drop; 3.75-foot less drop than NAA Average water years would be slightly better than NAA because flat spot would avoid the drop that happens in Jan-Feb under NAA, but short-term drops could cause some desiccation of eggs. Otherwise very similar to NAA. Note a little dip in the hydrograph in Dec; may be modeling artifact, but could dry some eggs for a short period then back up. Reason for short-term dips? Could be power production or chum flows.	Wet: 1286 to 1281 in early Oct, then up to 1286, Nov 1288 to 1286 and back up; late Dec down to 1281. Ave: Down to 1278' (Feb 1) (note dips in hydrograph each month) Dry: 1288' down to 1272 (late Jan). The drawdown in Dec-Feb would dessicate any kokanee redds along the shorelines in L. Roosevelt. Note: extreme drawdowns may not have straight 1:1 effect, could be lesser. See notes. To quantify effect: look at relationship of elevation to storage. H&H has storage. Compare to NAA. Also, see if GIS can analyze using bathymetry. Reply: no time to try quantification for draft. Qualitative only for now.	Kokanee in L. Roosevelt suggests shoreline spawning. Spawn Sept. 15-Oct 15, : Eggs incubate through Feb. Need temp units (degree days) to hatch; interactions with water temp. Depth of kokanee spawning not known in L. Roosevelt. Discussion: in Coeur d'Alene known to spawn deep, but in other places they spawn near the surface. Early spawners deposit eggs when reservoir is lower so fewer of those fish would be affected (deposition at lower level). Mitigation: Reduce water supply; determine magnitude of effect, improve mainstem spawning habitat - supplement substrate, reconnect off-channel habitats, etc., Increase habitat at lower elevations so more kokanee spawn at levels that don't get dewatered. Important to kokanee; applies to redband but only to portion that uses tributaries, but also changes alluvial fan habitat availability. Would need surveys for spawning depths to know magnitude of impact. For comparison, assuming 1:1 relationship between feet elevation change and eggs/fry desiccated. (Mitigation)
Temperature in the reservoir - kokanee are sensitive to temps. Note: Greyed this relationship because still investigating whether modeled results are real or a modeling artifact (suspected). Timing may not be able to determine until after draft.	See temperature stratification results	Found at depths below 120 meters to find temperature tolerance. Habitat suitability is function of temp and DO, but for the most part the DO is ok, not stratified. There is an area of Spokane arm that gets low DO. Kokanee about 62°F	Check out NAA - all four MOs appear to cause less stratification and the effect described. Determine mechanism (Eric and Sue) Thoughts - model may have pulled more through the lowest outlets and causing modeled change in stratification that wouldn't really happen? Main reservoir DO likely stays ok, but in the lower portions of the reservoir the model showed decreased stratification that could cause the temps at depth to increase up to 7°F compared to NAA in summer. Reduced	Later in the year DO declines. Higher up in water column in the Spokane arm (still about 5 mg/l, but may be an issue). Spokane arm would have decreased habitat suitability due to low DO. Midsummer anoxic DO from below/temp squeeze from above. Main reservoir DO likely stays ok, but in lower portions of the reservoir model showed less stratification that could cause temps to increase up to 7°F at depths of 100 to 120 m (approx), compared to NAA in summer. Reduced thermal refuge in	Main reservoir DO likely stays ok, but in the lower portions of the reservoir the model showed decreased stratification that could cause the temps at depth to increase up to 7°F compared to NAA in summer. Reduced thermal refuge area in summer habitat. Fish likely get more stress, more disease, may congregate in groundwater upwelling; may become more susceptible to entrainment if they move further downstream.	Later in the year start to decline DO higher up in the water column in the Spokane arm (still about 5 mg/l, but may be an issue). Reservoirs lower in Jun/Jul/Aug/Sep would result in less habitat available to kokanee. Increased thermal stress in habitats, increased disease,	See BPA report, Project 1995-011-00 Kokanee most sensitive; maybe lake whitefish (non-native), mountain whitefish If powerhouses are releasing from deep, and kokanee are oriented nearer to these powerhouses due to the thermal requirement described...they would be more susceptible to entrainment.

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Affected Environment Important Relationships/Criteria	Metric	Environmental Consequences NAA	Environmental Consequences MO1	Environmental Consequences MO2	Environmental Consequences MO3	Environmental Consequences MO4	Notes
			thermal refuge area in summer habitat. Fish likely get more stress, more disease, may congregate in groundwater upwelling; may become more susceptible to entrainment if they move further downstream. Mitigation: Don't know causation - can't develop mitigation without knowing. Habitat improvements to decrease temps in other areas of reservoir?	summer habitat. Fish likely get more stress and disease, may congregate in groundwater upwelling; become susceptible to entrainment if they move further downstream.			
Rufus Woods - not great habitat for kokanee, mostly FDR entrained.	–	–	–	–	–	–	–
Redband Rainbow Trout							
Elevations lower than 1283 feet can result in reduced access to tributary habitat. Becomes an issue for fall run rainbow. Note: See kokanee tab for analyses of MOs, this line for notes of anything specific to redband rainbow trout only.		See kokanee tab.	See kokanee tab.	See kokanee tab.	See kokanee tab.	See kokanee tab.	Check Dmitri on De–adwood reservoir reports. And Pat Monk at Kechelus and Kachees. 1283 feet is an operational metric. By Sep 30 at 1283 feet. Sep is peak run for kokanee/native fish.
Reservoir drawdowns increases susceptibility to predation of adults and juveniles moving from reservoir into tributaries (Feb-Apr) (h:) and outmigrating (typically with freshet, but outmigrate all year)Note: See kokanee tab for analyses of MO's, this line for notes of anything specific to redband rainbow trout only.	GC Elevation	See kokanee tab.	See kokanee tab.	See kokanee tab.	See kokanee tab.	Dry years - elevations lower than NAA, more susceptible to predation in Feb through May. Dry years have potential thermal issues. MO4 down to 1255, would have higher temps in reservoir. If higher tributary temperatures, they have to go through 20 vertical feet of drawdown zone to get to cooler reservoir temps. Fall run rainbow likely to fail. Near surface water likely unusable by salmonids. Also see kokanee tab.	Moving in typically in high flows that provide some cover, but reservoir can increase that predation rate. Important spawning tributaries - Sanpoil, blue Creek, Alder, Hall Creek, Nez Perce, Onion, Big Sheep, Deep Creek. Higher tributaries more susceptible to this effect because a smaller change in elevation would result in a larger area of exposure. Note recreational impact to tribe campground.
Transboundary reach mainstem river spawning. Drops in elevation Sept- Feb can strand eggs.	Stage at 720, 739	Stage at 739 (by border) 25 percentile. Stable. Median and above: End of Sep 1292, then increasing or stable until Jan 1, the time would drop from 1290 feet to about 1289 feet by the end of Feb. See hydrograph below.	25 percentile. Stable. Median and above. End of Sep 1292, Increasing or stable until Dec 1. Drops to 1292 feet by mid-Dec then down to 1289 feet by end of Feb. See graph below. Note: the elevations here are median, the 75% are similar pattern but	Similar to MO1 except starts lower at about 1290 feet Oct. 1, and slightly less steep drop in Dec. Jan to Feb same as NAA. Similar to MO1, but potentially less eggs affected due to lower starting location (fewer eggs	Same as NAA.	More variable hydrograph during spawning time period. See hydrograph. Lower stages for spawning could change distribution of spawning habitat, and variability could result in multiple spawning events being desiccated. Varial	WDFW Joint stock assessment annual reports. BPA. Chuck Lee author. Or Kalispel project on Cbfish. Project #1997-004-00 Mainstem spawning - inundated alluvial fans of reservoir and transboundary reach.

Affected Environment Important Relationships/Criteria	Metric	Environmental Consequences NAA	Environmental Consequences MO1	Environmental Consequences MO2	Environmental Consequences MO3	Environmental Consequences MO4	Notes
		Eggs could be dewatered in 75% of years, from elevation 1292 early in Feb to 1289 by end of Feb. Any eggs in the upper 3 feet of river could be dewatered if they were still in gravels after the first week of Feb. Later spawners would be more affected if they deposited eggs above 1292 feet while still rising in October.	start slightly lower, and characterization of the effect is the same. Compared to NAA, the drop in elevation starts sooner, so a higher proportion of eggs would be affected. Steep drop in early Dec: any eggs deposited from 1292 feet to 1294 feet would be dewatered (only became available in mid-Dec, no time to emerge). Any eggs deposited from 1289 feet to 1292 feet that have not emerged by early Feb would be desiccated. About 2 feet lower than MO1 and about 4 feet lower than NAA.	likely in the zone that becomes dewatered.)		zone effects likely to occur, and more eggs desiccated than NAA. Lower stages for spawning could change distribution of spawning habitat. Varial zone effects.	NOTE: Descriptions in "Data" columns refer to the transboundary elevation data (739.939), but the patterns are similar at 720.431. Both are displayed below and the filter button can be used to look at lines in any combination desired.
Fragmentation isolates populations, limits ability to express or complete all life history strategies. Fish attempt to migrate downstream and are then blocked from getting back to FDR. No change to this from any alternative.	–	Outmigrating redband, go below the dam and don't make it back up. Have detected as far downstream as East Sand Island. Fragmentation effects would continue.	Same as NAA.	Same as NAA.	Same as NAA.	Same as NAA.	McLellan, or unpublished data. Redband RM&E project annual report. PTAGIS data.
Northern Pikeminnow							
Drawdowns in spring can strand adult pike.	–	Level Oct to Jan, then decrease smoothly to mid-Mar, level to mid-Apr, decrease more to May, then initiate refill straight up to Jul fill. Springtime, water low, shorelines get vegetated, then levels come up and inundate the vegetation, pike spawn. Backwater habitats provide pike. They can wait for good conditions to spawn.	See graph - more variation in spring (up Mar 1 then dewater, but could be a modeling artifact. Potentially strand more pike in Dry years (20% of years) if spawning habitat is inundated and then dewatered again. Not Singers Bay because at lower elevation, but could be other bays/backwaters that inundate then dewater. Wet and average years same as NAA.	Same as MO1.	Same as NAA.	Similar to MO1; same pattern at slightly different elevation.	Personal communication, Bret Nine (unpublished data documented pike stranding event in Singers Bay). Elevation 1253 dries out Singers Bay, stranding adult pike (personal communication, Bret Nine), but no difference between alternatives noted. Pike are very adaptive and opportunistic; they will wait for conditions to spawn so minor changes in elevations or timing would not affect their spawning success. Subsequent note: Originally said no differences noted, but after H&H data visualized, potential stranding in MO1, 2, and 4 in Dry years possible.
Residence time - see kokanee tab, influences entrainment, may increase rate of dispersal downstream; hastens rate of invasion.	Outflows and retention time.	See kokanee tab for RT. Pike established and increasing in the reservoir. Juveniles likely being entrained and invading further downstream.	Increased outflows in Dec, 3% to 5% less in May to Sep. See also kokanee tab for RT data. Dec difference - not likely to be in that area in Dec. Slight	1% to 6% lower Mar-Jul. Dec. up to 13% higher. Adult Pike not likely there at that time, but juveniles could be entrained. Walleye are there all the time, likely to increase entrainment in Dec. Slight decrease in risk March-July. SMB, pikeminnow all	Same as MO1.	Dry year increased outflows in May-Jul increases entrainment risk. See kokanee for retention time data. May, June, July, Aug RT 21% to 29% faster than NAA. Dry years increased outflows in summer. Wet/Ave years similar to MO1. Dry years: Decreased	LeClaire (2000), documented the zooplankton and kokanee. Juvenile pike in system now. Any MOs that decrease retention time. Lower reservoir elevation, more likely to moving downstream, pike more shoreline, but up to 80 feet noted.

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			decrease in entrainment risk in May to Sep.	similar risk. See also kokanee tab for RT data.		retention time (21% to 29% faster) and, increased outflows may increase rate of dispersal downstream in dry years. Summertime is when juvenile pike would be foraging and more susceptible to entrainment.	
Spring ops impede boat launches; impede suppression efforts.	–	Wet years: Apr 15.	–	–	–	–	–
Ave and Dry years begin refill at 1245 feet, ramps don't go out of the water. Would continue to net and remove pike at current level of effort.	Exceedance plots: 99% exceedance plot reaches 1235 feet in mid-Mar, 2 weeks earlier than NAA (Apr 1), 75% exceedance is similar to NAA. Median of low water years (lowest 20%) is Apr 15 (NAA is Apr 8) so one week sooner than NAA. Elevation comparisons: 1235 feet by Apr 9, 6 days sooner. One to two weeks less time to do pike suppression efforts. See notes for numeration.	Same as MO1	Same as NAA.	NA	Unpublished data, Colville Tribe 60 nets removed 107 pike in one week by 1 crew. Note - would normally have 3 crews at that time. Mitigation: extend boat ramps to ensure year-round access at lower elevations. Mitigation - Block nets. Mitigation: increase non-native predator control efforts	–	–
Game Fish							
Migratory Fishery – Rainbow Trout							
Similar impacts as redband and kokanee, except no spawning impacts.	–	–	See kokanee tab	See kokanee tab	See kokanee tab	See kokanee tab	–
Reservoir elevation can affect water quality in the location of the net pens.	Surface DO and temperature at locations, May 15 to Jun 15.	See Mitigation Fishery Water Quality summary. Temp, DO at locations can affect the fish prior to release or force early release. Disease and WQ issues.	Similar to NAA.	Similar to NAA.	Similar to NAA.	Two Rivers location, up Spokane arm, warmer in June (check data). Keller (closest to dam) - Ave years, very small changes; but	Drawdown affects to net pens. Surface temps and TDG at net pen locations, Expect more impacts in Spokane arm locations? See Mitigation Fishery Location water quality summary.

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						see changes in stratification with increase in temperature, potentially allows cooler water to spread to surface; slight decrease in surface (applies to all MOs). All four MOs show a warmer than NAA in the fall in all years except LF/HT, difficult to figure causation - looks like decreasing stratification, maybe pulling only out of deep?	MO2 and MO4 potentially higher percentage of habitat in Spokane Arm with low DO, thereby reducing habitat. Causation not determined; may be modeling error.
Reservoir elevations control how far the lake backs up into the Spokane arm, affecting the depth and therefor the rate of water freezing. Lower elevations can cause earlier freezing and early release of net pens when they do not survive as well.	Reservoir elevation -	Have not seen in past operations, would not freeze.	No effects	NO Effect	No effects	6 feet to 8 feet lower in Dec/Jan	Lower reservoir elevations could increase freezing, would have to move fish out sooner. Net pens, entry fish go into pens in Fall and rear into spring; Net pens are just around corner from reservoir, don't think freezing would be an issue.
Date of refill could put releases into a time where multiple other stressors have made released fish more susceptible to mortality from TDG, temps, etc.	Initiation of refill	–	–	–	–	–	–
Retention time	Get current initiation of refill date. Refill begins early May	Same as NAA	Same as NAA	Same as NAA	Refill initiates 2nd week of June in dry years. Ave years = similar to NAA Wet years, 2 weeks earlier in NAA. Delay of refill initiation in dry years would result in releasing hatchery fish up to 4-6 weeks later, where they would likely encounter more stressful rearing conditions (higher temps and potentially TDG). Or, if released prior to initiation of refill, they would be more susceptible to entrainment. Conditions in dry years likely to be already stressful to fish, further exacerbated by delay of release. IN wet years, the earlier release could be reduced TDG and temp stress (likely experience higher TDG but lower thermal stress.	Target releases to initiation of refill date. Date of refill could change with alternatives.	–

Affected Environment Important Relationships/Criteria	Metric	Environmental Consequences NAA	Environmental Consequences MO1	Environmental Consequences MO2	Environmental Consequences MO3	Environmental Consequences MO4	Notes
Deeper drawdown impacts mitigation fishery... Lower retention time can increase susceptibility to entrainment in the weeks post-release. (As compared to general entrainment risk discussed in kokanee tab.)	See retention time graphs, similar to kokanee tab. June 1 RT	June 1 RT: (Ave, Wet, Dry) = 21 days, 16 days, 34 days. Fish released at initiation of refill, about early May.	June 1 RT: (Ave, Wet, Dry) = 21 days, 16 days, 35 days. Same as NAA.	June 1 RT: (Ave, Wet, Dry) = 21 days, 16 days, 35 days. Similar to NAA. 1 day higher RT.	June 1 RT: (Ave, Wet, Dry)= 22d, 16d, 35d Same as NAA. Or slightly less risk. 1 day higher retention time.	Keller Location: Ave Years; Similar or slight increase in retention time, slightly cooler at surface Dry Years: Decrease of 9 days average in May-Jun period in lower flow years (missing full pool), no change to temps/TDG. June 1 RT: (Ave, Wet, Dry) = 21 days, 16 days, 25 days Water quality would not change operation of net pens, but would expect greater entrainment of mitigation fish in dry water years. 10 days shorter retention time; 40% lower, much higher entrainment risk. Deep water cold refugia is impacted, but not seeing much change at surface. McNary measure triggers in low flow years, but it is gradational of how much is needed, so 2013 likely providing less storage water (not much change in retention time; 2015 probably shows using full 2 MAF. RT note: 40% lower RT. Not known if RT to recruitment to tag recovery is linear relationship, but definitely much higher risk of entrainment loss.	Retention time 4 weeks post-release correlated with tag returns when reservoir elevations below 1250' elevation. This occurs in wet and average years in all MO's, and Dry year MO4 (see summary elevation comparisons).
Fishery community - component of the fishery -	–	Note: Walleye, smallmouth bass, pikeminnow, etc., are generalists and favored by reservoir environments. Changes in reservoir operations unlikely to affect populations. See kokanee tab for food web/productivity that fuels these populations. Similar relationships, but relative to prey fish. Changes in entrainment risk could increase their populations downstream. See pike tab. Walleye Spawning Spokane Arm - move in Feb, spawn in April. Very successful spawners, entrainment moves them	–	–	–	–	Spokane arm - perch comprised 91% of juvenile fish in 2017 (Spokane 2017 annual report), FDR overall Fish caught by anglers (2015-2017): 150,000 hatchery rainbow trout 260,000 walleye 59,000 smallmouth bass Wild rainbow 15,000 Wild kokanee 16,000

Affected Environment Important Relationships/Criteria	Metric	Environmental Consequences NAA	Environmental Consequences MO1	Environmental Consequences MO2	Environmental Consequences MO3	Environmental Consequences MO4	Notes
		through, LRW, down to mid-C and beyond. Spokane arm shifted almost entirely to non-native game fish, mostly perch. Walleye negatively impacted by anything that lowers productivity (most walleye captured are low condition, probably food-limited).					
TDG effects net pen fish in Lake Rufus Woods.	–	Net pens in L. Rufus Woods, as TDG increases have to release them into the lake rather than out to tributaries throughout the reservation for resources. Don't know survival of net pen fish, or impact on releasing them there. (Commercial net pen fish have very high mortality). May be able to release more fish into the tributaries to serve as resource.	TDG lower than NAA.	–	–	–	Increased flows increase TDG. Elevation below 1265 with high outflows increases TDG. Maintenance measure should increase TDG, but other measures reduce outflows during those periods so overall TDG is lower in all alts. Could impact resident fish.
Lake Rufus Woods rainbow trout, walleye, native fish (prey) bluegill,	–	Entrainment - flows affect entrainment but don't have it quantified. Could also be similar effect entraining food similar to kokanee tab in Lake Roosevelt. Fish typically spawn on shorelines. Few tributaries. Lake elevations typically stable during day but wide fluctuations at night.	–	–	–	–	–

Baldwin and Polacek, 2002
Beeman et al., 2003
Bonar et al., 2000
Eagles-Smith, 2016
Hansen et al., 1992
LeClaire, 2000
Nine, Bret. Personal communication.
Willacker, 2016

1 **Table 3-76. Average monthly retention time for each alternative including change from NAA**
2 **and percent change.**

Month	Average Retention Time	Average Change	Average Percent Change	Average Dry Retention Time	Dry Change	Percent Dry Change	Average Wet Retention Time	Wet Change	Percent Wet Change
MO1									
October	73.8	0.1	0%	75.8	-0.3	0%	72.5	-0.1	0%
November	51.6	-0.4	-1%	53.0	-0.1	0%	51.1	-0.4	-1%
December	45.0	-2.7	-6%	47.7	-3.5	-7%	43.0	-2.4	-6%
January	41.1	-2.2	-5%	47.1	-3.3	-7%	34.5	-1.9	-6%
February	33.8	-0.2	-1%	45.8	-3.1	-7%	25.4	-2.4	-9%
March	39.2	0.1	0%	60.3	1.8	3%	24.1	-2.1	-9%
April	34.5	-0.1	0%	52.8	0.3	1%	19.6	-1.0	-5%
May	23.7	0.5	2%	35.4	1.4	4%	14.6	-0.5	-3%
June	26.8	0.1	0%	38.3	0.7	2%	20.1	0.2	1%
July	33.0	-0.1	0%	46.1	-0.4	-1%	27.2	0.1	0%
August	41.3	0.0	0%	44.9	0.4	1%	34.3	0.3	1%
September	65.3	0.0	0%	64.4	0.6	1%	59.8	0.2	0%
MO2									
October	81.3	7.6	9%	83.2	7.1	9%	79.7	7.2	9%
November	50.3	-1.6	-3%	52.1	-0.9	-2%	9.0	-2.6	-5%
December	42.2	-5.5	-13%	45.5	-5.6	-12%	40.5	-4.9	-12%
January	41.9	-1.4	-3%	46.3	-4.1	-9%	35.2	-1.2	-3%
February	33.7	-0.3	-1%	46.2	-2.7	-6%	23.9	-3.9	-16%
March	40.3	1.2	3%	61.8	3.2	5%	24.7	-1.5	-6%
April	35.2	0.7	2%	54.0	1.5	3%	19.8	-0.7	-4%
May	24.0	0.8	3%	35.8	1.8	5%	14.8	-0.2	-2%
June	27.0	0.4	1%	38.7	1.1	3%	20.1	0.2	1%
July	33.2	0.1	0%	47.3	0.9	2%	27.2	0.1	0%
August	41.4	0.1	0%	45.8	1.2	3%	34.3	0.3	1%
September	62.4	-2.8	-5%	59.0	-4.7	-8%	58.4	-1.2	-2%
MO3									
October	79.2	5.5	7%	81.2	5.1	6%	77.7	5.1	7%
November	50.4	-1.5	-3%	52.2	-0.9	-2%	49.3	-2.3	-5%
December	46.4	-1.3	-3%	49.5	-1.7	-3%	44.6	-0.8	-2%
January	45.7	2.4	5%	49.1	-1.3	-3%	39.9	3.4	9%
February	34.1	0.1	0%	48.7	-0.1	0%	27.1	-0.6	-2%
March	39.4	0.4	1%	59.0	0.5	1%	25.6	-0.6	-2%
April	34.6	0.0	0%	51.9	-0.5	-1%	20.3	-0.2	-1%
May	23.8	0.6	3%	35.7	1.7	5%	15.0	-0.1	-1%
June	26.8	0.2	1%	38.8	1.2	3%	20.0	0.1	0%
July	33.1	0.0	0%	47.3	0.9	2%	27.1	0.0	0%
August	41.4	0.1	0%	45.8	1.3	3%	34.2	0.3	1%

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Month	Average Retention Time	Average Change	Average Percent Change	Average Dry Retention Time	Dry Change	Percent Dry Change	Average Wet Retention Time	Wet Change	Percent Wet Change
September	65.4	0.1	0%	65.0	1.3	2%	59.8	0.2	0%
MO4									
October	82.1	8.4	10%	84.2	8.1	10%	80.0	7.4	9%
November	51.6	-0.3	-1%	52.8	-0.2	0%	51.1	-0.4	-1%
December	45.0	-2.7	-6%	47.8	-3.4	-7%	43.5	-2.0	-5%
January	40.1	-3.2	-8%	44.6	-5.8	-13%	35.7	-0.8	-2%
February	33.8	-0.2	-1%	45.5	-3.4	-7%	25.5	-2.2	-9%
March	39.2	0.1	0%	63.1	4.6	7%	24.3	-1.8	-7%
April	34.7	0.1	0%	53.3	0.8	2%	19.6	-0.9	-5%
May	22.5	-0.7	-3%	26.8	-7.2	-27%	14.7	-0.4	-3%
June	25.0	-1.6	-7%	29.4	-8.2	-28%	20.0	0.1	1%
July	30.3	-2.8	-9%	38.4	-8.0	-21%	27.1	0.0	0%
August	38.8	-2.5	-7%	39.9	-4.6	-12%	34.2	0.3	1%
September	66.3	1.0	1%	67.1	3.4	5%	59.8	0.1	0%

3 **Table 3-77. Average monthly retention time for the NAA by water year.**

Month	Average Retention Average	Dry Retention Time	Average Wet Retention Time
October	73.7	76.1	72.6
November	51.9	53.1	51.5
December	47.7	51.2	45.4
January	43.3	50.4	36.4
February	34.0	48.9	27.7
March	39.0	58.5	26.2
April	34.6	52.4	20.5
May	23.2	34.0	15.1
June	26.7	37.6	19.9
July	33.1	46.4	27.1
August	41.3	44.5	33.9
September	65.3	63.8	59.6

Table 3-78. Change in Temperature and Total Dissolved Gas at Select Net Pen Locations in Lake Roosevelt for Each Alternative in Representative Water Years.

Δ from NAA	2011 TDG	2011 Temperature	2012 TDG	2012 Temperature	2013 TDG	2013 Temperature	2014 TDG	2014 Temperature	2015 TDG	2015 Temperature
MO1										
RT (Days)	-0.5	4.8	0.0	0.3	1.8					
Sherman Creek Seg-153	0.0	0.0	-0.7	0.0	0.0	0.0	-0.1	0.0	0.1	0.2
Hall Creek Seg-186	0.3	-0.1	-1.0	0.2	1.4	-0.3	-0.1	0.0	1.3	0.7
Hunters Seg-213	0.1	0.0	-1.4	0.3	1.7	-0.8	-0.2	0.0	1.1	1.0
Seven Bays Seg-253	0.5	-0.1	-1.6	0.5	1.6	-0.5	-0.5	0.2	1.1	0.9
Lincoln Seg-259	0.4	-0.1	-0.8	0.3	1.1	-0.4	-0.5	0.1	1.0	0.9
Keller Seg-291	0.3	-0.1	-1.9	0.7	1.7	-0.6	-0.7	0.3	0.8	0.7
Two Rivers Seg-542	0.0	0.0	0.4	0.0	1.2	-0.5	0.0	0.1	0.9	0.6
MO2										
RT (Days)	-0.4	4.7	0.0	0.5	2.0					
Sherman Creek Seg-153	0.0	0.0	-0.7	0.0	0.2	-0.1	-0.2	0.0	0.7	0.0
Hall Creek Seg-186	0.4	-0.1	-1.1	0.2	1.7	-0.4	-0.1	0.0	1.4	0.8
Hunters Seg-213	0.1	0.0	-1.4	0.3	2.0	-0.9	-0.4	0.1	1.2	1.1
Seven Bays Seg-253	0.5	-0.1	-1.6	0.5	2.1	-0.7	-0.6	0.2	1.3	1.0
Lincoln Seg-259	0.3	-0.1	-0.8	0.3	1.5	-0.5	-0.7	0.2	1.2	1.0
Keller Seg-291	0.3	-0.1	-1.9	0.7	2.0	-0.6	-1.1	0.4	0.9	1.0
Two Rivers Seg-542	0.0	0.0	0.4	0.0	1.4	-0.5	0.1	0.1	0.7	0.6
MO3										
RT (Days)	-0.1	5.0	0.0	0.5	1.9					
Sherman Creek Seg-153	0.0	0.0	-0.8	0.1	0.0	0.0	-0.2	0.0	0.1	0.2
Hall Creek Seg-186	0.0	0.0	-2.6	0.5	-0.3	0.0	-0.1	0.0	1.2	0.7
Hunters Seg-213	-0.2	0.1	-3.3	0.7	-0.4	0.2	-0.3	0.1	1.1	0.9
Seven Bays Seg-253	-0.4	0.2	-3.3	1.2	-0.4	0.3	-0.6	0.2	1.1	0.9
Lincoln Seg-259	-0.4	0.1	-2.5	0.9	-0.3	0.1	-0.6	0.2	1.0	0.8
Keller Seg-291	-0.5	0.2	-3.2	1.1	-0.7	0.3	-0.9	0.4	0.7	0.7
Two Rivers Seg-542	0.0	0.1	0.0	0.5	-0.2	0.1	0.1	0.0	0.9	0.7
MO4										
RT (Days)	-0.5	4.8	-1.4	0.5	-8.8					
Sherman Creek Seg-153	0.0	0.0	-0.7	0.0	0.2	-0.1	-0.2	-0.1	0.7	0.0
Hall Creek Seg-186	0.4	-0.1	-1.1	0.2	1.7	-0.4	-0.1	-0.2	1.4	0.8
Hunters Seg-213	0.1	0.0	-1.4	0.3	2.0	-0.9	-0.4	0.1	1.2	1.1
Seven Bays Seg-253	0.5	-0.1	-1.6	0.5	2.1	-0.7	-0.6	0.1	1.3	1.0
Lincoln Seg-259	0.3	-0.1	-0.8	0.3	1.5	-0.5	-0.7	0.1	1.2	1.0
Keller Seg-291	0.3	-0.1	-1.9	0.7	2.0	-0.6	-1.1	0.0	0.9	1.0
Two Rivers Seg-542	0.0	0.0	0.4	0.0	1.4	-0.5	0.1	-0.1	0.7	0.6

Note: None of these locations were calibration points in the model, and none of the temperature or TDG changes noted in the table represent change outside of the modeling error range. Retention time was included in this table as a preliminary exercise for team discussion purposes; retention time data used in analyses is presented separately.

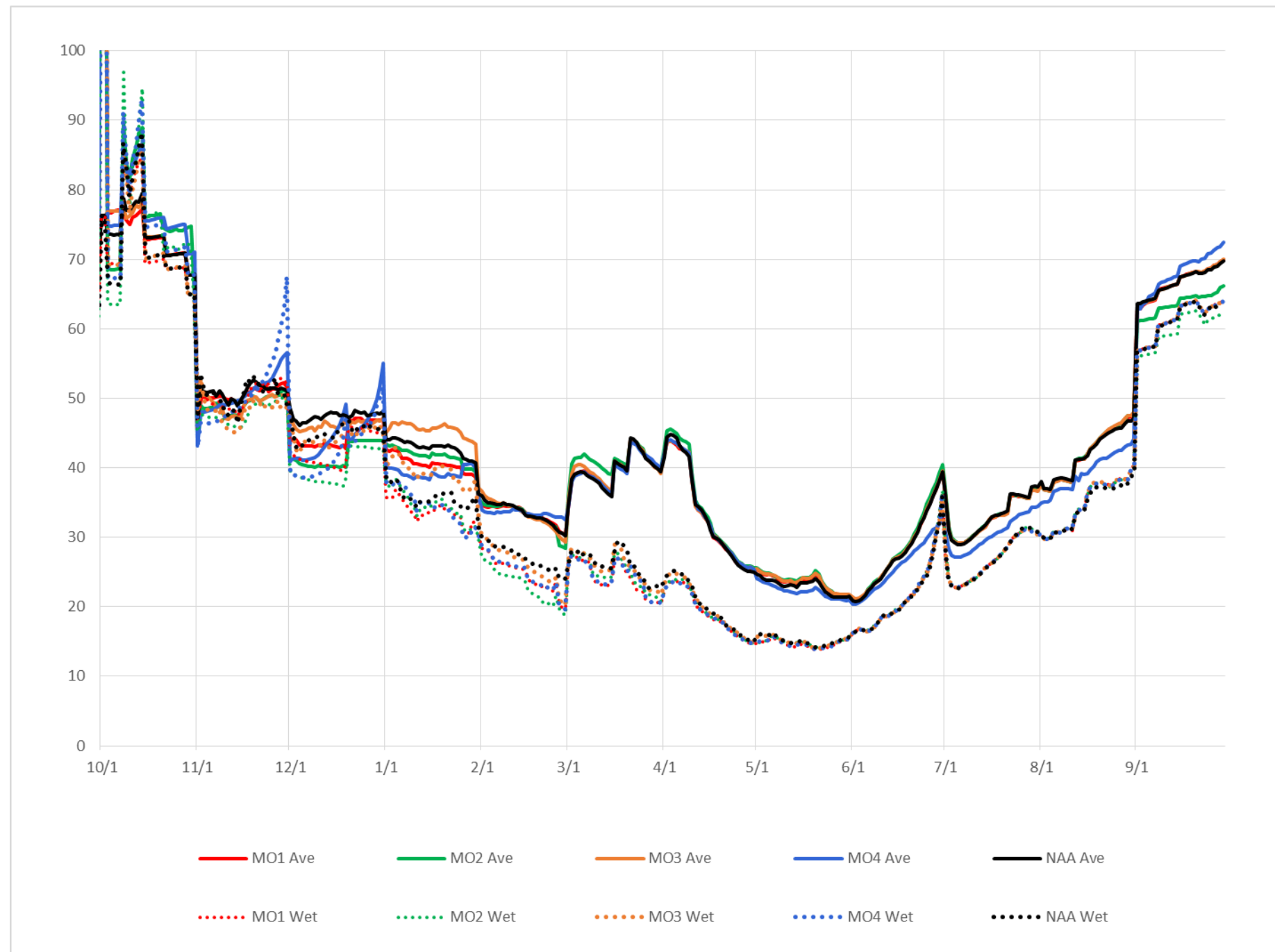


Figure 3-1. Summary hydrograph showing median retention time throughout the water year in wet and average water years.

3.8.3 Chief Joseph Dam to McNary Dam

Table 3-79. Columbia River Resident Fish Qualitative Effects Analysis Matrix

Affected Environment Important Relationships/Criteria	Affected Environment Metric	Environmental Consequences NAA	Environmental Consequences MO1	Environmental Consequences MO2	Environmental Consequences MO3	Environmental Consequences MO4	Notes
Bull Trout							
Chief Joseph Dam to Priest Rapids Dam							
Cold water required. Prefer temperatures less than 15°C can limit distribution.	Temperatures in FMO habitat – percent of days of 15°C – Oct to Jul	Under the NAA, temperatures would support FMO habitat from Oct through Jul (when bull trout are present). CHJ = 18.9% of days over 15°C; high = 19.0°C PRD = 21.1% of days over 15°C; high = 21.6°C MCN = 25.4% of days over 15°C; high = 23.7°C Under the NAA, temperatures will support bull trout from mid-Oct through mid-Jun. Bull trout are found at several dams during Jul, during higher temperatures, as well. Bull trout will continue to use the Columbia River as migratory and overwintering habitat during this time period.	CHJ = 18.8% of days over 15°C; high = 18.7°C PRD = 21.9% of days over 15°C; high = 21.7°C MCN = 25.0% of days over 15°C; high = 23.8°C Under MO1, there is no difference from NAA.	CHJ = 18.8% of days over 15°C; high = 18.7°C PRD = 21.9% of days over 15°C; high = 21.7°C MCN = 25.0% of days over 15°C; high = 23.8°C Under MO1, there is no difference from NAA.	CHJ = 18.9% of days over 15°C; high = 19.3°C PRD = 21.5% of days over 15°C; high = 21.8°C MCN = 25.2% of days over 15°C; high = 23.8°C Under MO1, there is no difference from NAA.	CHJ = 19.1% of days over 15°C; high = 18.7°C PRD = 21.4% of days over 15°C; high = 21.8°C MCN = 24.5% of days over 15°C; high = 24.0°C Under MO1, there is no difference from NAA.	Bull trout are seen in this river reach in all months of the year, even when temperatures exceed 18°C. However, the majority are seen in late spring and early summer ~ leaving the mainstem for cooler habitats. PUDs have bull trout management plans. PIT data mouth of Okanagan, etc.
Dams create migration barriers for adfluvial populations. May be more useful to couch in terms of delays, not barriers.	Fish passage at dams – mean bull trout per year.	Ladder counts at PUDs show fish in the system from Apr through Nov. Mean BT/YR: MCN = 0.0, PRD = 4.0, WAN = 4.4, RIS = 46.8, RRC = 98.7, WEL = 42.6. Under the NAA, bull trout will continue to pass all dams in this reach except CHJ. An unknown number may be delayed or blocked.	No difference from NAA.	No difference from NAA.	No difference from NAA.	No difference from NAA.	Projects typically don’t study bull trout, some opportunistic sampling/tagging. Wells has array and weir at Okanagan that may provide additional information on movement. Possibly Wenatchee at Tumwater Dam. PUD annual reports.

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Hanford Reach							
Temperatures to support FMO Oct to Jul.	Temperatures in FMO habitat.	Water temperature in Hanford Reach. Temperatures currently support FMO habitat form Oct through Jun (when bull trout are present). This is the same as Line 10, above. We would use the same metrics as PRD. PRD = 21.1% of days over 15°C; high = 21.6°C. Under the NAA, water temperatures in the Hanford reach are conducive for bull trout FMO habitat. However, bull trout are rarely found here.	PRD = 21.9% of days over 15°C; high = 21.7°C No difference from NAA	PRD = 21.5% of days over 15°C; high = 21.8°C Under MO2, there is no difference from NAA	PRD = 21.4% of days over 15°C; high = 21.8°C Under MO3, there is no difference from NAA	PRD = 21.8% of days over 15°C; high = 22.3°C Under MO4, temperature is slightly higher because of changes in upstream operations. We do not expect few 10ths of a degree to have difference impacts than the NAA.	Rarely seen below PRD. Too far from source tributaries.
TDG Effects – bull trout leaving in spring before TDG increases. The USFWS recommends maintaining TDG at 110% or less for bull trout habitat.	Percent of days mean daily TDG levels over 110 at CHJ tailwater and MCN forebay from Oct to Jul.	TDG over 110%; CHJ tailwater = 11.3% MCN forebay = 26.0% Under the NAA, there continues to be a risk for negative impacts from TDG on bull trout May through Jul in this reach of the river.	TDG over 110%; CHJ tailwater = 11.8% MCN forebay = 28.0% No change from NAA	TDG over 110%; CHJ tailwater = 16.7% MCN forebay = 15.8% Under MO2, TDG is expected to have greater potential for negative effects to bull trout just below CHJ and a reduced potential for negative impacts near McNary Dam.	TDG over 110%; CHJ tailwater = 10.1% MCN forebay = 25.5% Under MO3, there would be a slight reduction in the potential for negative effects from TDG to bull trout populations.	TDG over 110%; CHJ tailwater = 8.2% MCN forebay = 29.8% (70.2% tailwater) No change from NAA	Several studies found that bull trout were not severely impacted by TDG because of their ability to sound and avoid high TDG surface waters. Weitkamp et al., 1980; Weitkamp et al., 2003.
White Sturgeon							
Dams create barriers to movement.	Sturgeon passage at dams	Sturgeon have been documented passing upstream at only TDA. Downstream passage is more common. Recruitment from upstream sources suggests downstream passage at most dams. Under the current conditions white sturgeon will continue to pass upstream at TDA in limited numbers, while larger numbers of white sturgeon will continue to pass downstream of PUD and project dams in this reach of the Columbia River.	No measures address upstream migration of white sturgeon, so no difference from NAA.	No measures address upstream migration of white sturgeon, so no difference from NAA.	Under MO3, the four lower Snake River dams will be removed and white sturgeon from MCN pool and the Hanford Reach will have access to the Hells Canyon Complex. Connectivity of these populations would likely increase spawning and recruitment success and would increase fitness of the entire population.	No measures address upstream migration of white sturgeon, so no difference from NAA.	Upstream sources often cited as seeding downstream habitats. Downstream movement from upper Columbia River pools supports this (2011). Sturgeon can't use ladders. Emigration out is 5% or less. PUDs stock since 2011, 27,000 hatchery fish, common juveniles in CHJ to PRD. Check if supplementation fish or CRITFC fish (experimental sturgeon culture, released 20,000 juveniles at Rock Island about 2003). Some remain, some flushed out, see all the way down below MCN. Hildebrand et al., 2016; and 2013 Management Plan.

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Affected Environment Important Relationships/Criteria	Affected Environment Metric	Environmental Consequences NAA	Environmental Consequences MO1	Environmental Consequences MO2	Environmental Consequences MO3	Environmental Consequences MO4	Notes
Spawning sites limited in slow water habitats. Need high spring flows over cobble/gravel habitats at 10°C to 12°C to initiate spawning (May to Jun).	Water flows over cobble/gravel substrates (May to Jun) 25th percentile at PRD.	Currently, adequate spawning substrates are located in the tailwaters of CHJ and the PUD dams. Mean 25th percentile (May to Jun) for NAA = 207,431 kcfs. Peak is 247,375 kcfs. Under the current conditions flows and temperatures are adequate for white sturgeon spawning. However, suitable habitat or substrate are limiting. They lack cobble/gravel substrate. Limited to tailraces at PUDs and Hanford Reach. Check PUDs. Substrate may not be limiting for spawning.	Mean 25th percentile (May to Jun) for MO1 = 202,565 kcfs (2.3%). Peak is 242,822 kcfs. MO1 high flows are ~ 2.3% lower and white sturgeon spawning success may be somewhat reduced when compared to the NAA. Lower number of adults may limit success even under high water years. Supplemental fish should help augment these populations.	Mean 25th percentile (May to Jun) for MO2 = 204,499 kcfs (1.4%). Peak is 245,911 kcfs. MO2 high flows are ~ 1.4% lower and white sturgeon spawning success may be somewhat reduced when compared to the NAA.	Mean 25th percentile (May to Jun) for MO3 = 202,474 kcfs (2.4%). Peak is 242,968 kcfs. MO3 high flows are ~ 2.4% lower and white sturgeon spawning success may be somewhat reduced when compared to the NAA.	Mean 25th percentile (May to Jun) for MO3 = 202,412 kcfs (2.4%). Peak is 242,896 kcfs. MO3 high flows are ~ 2.4% lower and white sturgeon spawning success may be somewhat reduced when compared to the NAA.	White sturgeon generally initiate spawning at 10°C to 12°C during the peak or descending limb of the hydrograph. Higher flow years have better success. Tailraces of dams (less than a mile) and open river in Hanford Reach areas are only spawning habitats. Substrate is stable, probably not affected by flows. Hildebrand et al., 2016.
Higher flows can influence rate of outmigration of hatchery supplementation fish, resulting in loss of juveniles from project area. Some of these fish are seen downstream of MCN.	Outflows in May/Jun. Percent increase or decrease in high flows in May/Jun at PRD.	Flows rise rapidly starting in May and peak ~ 4 Jun, then drop rapidly till Jul. Mean median flow (May to Jun) for NAA at PRD = 168,562 kcfs. Under current conditions, an unknown number of hatchery supplemental white sturgeon will be entrained from the project area.	Mean median flow (May to Jun) for MO1 at PRD = 163,644 kcfs (2.9). Slightly lower flows under MO1 would decrease risk for outmigration of supplemental fish from the project area.	Mean median flow (May to Jun) for MO2 at PRD = 165,727 kcfs (1.7). Slightly lower flows under MO2 would decrease risk for outmigration of supplemental fish from the project area.	Mean median flow (May to Jun) for MO3 at PRD = 163,355 kcfs (3.1). Slightly lower flows under MO3 would decrease risk for outmigration of supplemental fish from the project area.	Mean median flow (May to Jun) for MO4 at PRD = 167,638 kcfs (0.5). Slightly lower flows under MO4 would decrease risk for outmigration of supplemental fish from the project area.	Populations are not self-sustaining. Hatchery supplementation is needed to build populations. Hatchery fish are released in May/Jun timeframe. Target release of 200g fish. PUDs have natural recruitment studies information. Higher flows could increase outmigration of hatchery-raised supplemental fish from the project areas. PUDs time spill releases and put fish in locations to reduce losses of hatchery fish. High flows promote spawning of wild fish. Timing of releases is important for retaining these fish. June is peak critical month for entrainment. More easily lost from project area. Question for group – does the team want high flows in May and June to promote spawning or low flows to promote retention of hatchery fish?

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Natural recruitment is inconsistent. Very high flow years can lead to recruitment. When discharge rates at MCN reach or exceed 250 kcfs, there is generally a detectible level of recruitment in the reservoirs.	Outflows in May/Jun. Average daily discharge from May through Jul peak flows for NAA 25% is over 250 kcfs at MCN.	The NAA shows median flows for May through Jul at 245,457 kcfs. Days over 250 kcfs = 10.1% (9.3 days).	The MO1 alternative shows median flows for May through Jul at 242,054 kcfs (1.4%). Days over 250 kcfs = 9.6% (8.8 days). Slightly reduced flows at MCN for MO1 will likely result in minor reductions in spawning success for white sturgeon.	The MO2 alternative shows median flows for May through Jul at 242,470 kcfs (1.2%). Days over 250 kcfs = 9.6%. Slightly reduced flows at MCN for MO2 will likely result in minor reductions in spawning success for white sturgeon.	The MO3 alternative shows median flows for May through Jul at 242,929 kcfs (1.0%). Days over 250 kcfs = 9.6%. Slightly reduced flows at MCN for MO3 will likely result in minor reductions in spawning success for white sturgeon.	The MO4 alternative shows median flows for May through Jul at 241,812 kcfs (1.5%). Days over 250 kcfs = 9.9%. Slightly reduced flows at MCN for MO4 will likely result in minor reductions in spawning success for white sturgeon.	PUDS natural recruitment data. Very minimal to no recruitment in pools between PRD and CHJ. General theory is that high flow events can lead to low-level natural recruitment, but it is still very low due to low numbers of adults in area. When discharge rates at MCN reach or exceed 250 kcfs, there is generally a delectable level of recruitment in the reservoirs. NPPC, 2013.
Hanford Reach – very minimal recruitment now. Sturgeon need very high flows to spawn and recruit. High flows distribute larvae before exogenous feeding, provide drift, and trigger spawning.	High flows – Compare 25% exceedance for each alternative.	Currently, adequate spawning substrates are located in the tailwaters of CHJ and the PUD dams. Mean 25th percentile (May to Jun) for NAA = 207,431 kcfs. Peak is 247,375 kcfs. Under current conditions, white sturgeon spawning will result in limited recruitment in high flow years.	Mean 25th percentile (May to Jun) for MO1 = 202,565 kcfs (2.3%) Peak is 242,822 kcfs. MO1 high flows are ~2.3% lower and white sturgeon spawning success may be somewhat reduced when compared to the NAA.	Mean 25th percentile (May to Jun) for MO1 = 202,565 kcfs (2.3%) Peak is 242,822 kcfs. MO1 high flows are ~2.3% lower and white sturgeon spawning success may be somewhat reduced when compared to the NAA.	Mean 25th percentile (May to Jun) for MO1 = 202,565 kcfs (2.3%) Peak is 242,822 kcfs. MO1 high flows are ~2.3% lower and white sturgeon spawning success may be somewhat reduced when compared to the NAA.	Mean 25th percentile (May to Jun) for MO1 = 202,565 kcfs (2.3%) Peak is 242,822 kcfs. MO1 high flows are ~2.3% lower and white sturgeon spawning success may be somewhat reduced when compared to the NAA.	Young-of-year recruitment and timing same as below MCN, but far lower recruitment in MCN pool.
Flow and turbidity affect suitability and amount of spawning habitat. Need turbidity for egg and larval survival.	Outflows at projects, and turbidity levels in water quality data.	Limited qualitative evaluation of turbidity was completed by the water quality team. No issues with turbidity and suspended sediments.	No difference from NAA anticipated.	No difference from NAA anticipated.	Significant increase during breaching of lower Snake River dams and for several years after depending on erosion rate of deposited materials. Subsequent amounts dependent on watershed land-use practices and runoff events.	No difference from NAA anticipated.	Water qualitative matrix.
TDG – 50% mortality at elevated TDG ~ 130%. Larval sturgeon are most impacted as they drift in the water column.	Percent of days TDG over 118% = no mortality (Counihan et al., 1998).	Percent of days over 118%; MCN = 0.9% CHJ = 0.8% Under the NAA, TDG is not likely to have a negative impact on white sturgeon.	Percent of days over 118%; MCN = 0.6%; CHJ = 0.8% No change from NAA.	Percent of days over 118%; MCN = 0.6% CHJ = 0.8% No change from NAA.	Percent of days over 118%; MCN = 0.6% CHJ = 0.8% No change from NAA.	Percent of days over 118%; MCN = 1.1% CHJ = 0.8% No change from NAA.	Elevated TDG at tailraces are likely source of stress. Larval sturgeon are more impacted as they drift in the water column. Adult sturgeon use deep habitats. This metric was not effective in separating the alternatives.

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Extreme low flows and higher reservoir temperatures can cause increased mortality of adults in and females going attritic above 18°C.	Temperatures in reservoirs (flows are related to temperature).	Temperature and flow in MCN reservoir. Mean temperature (Jul to Aug) = 21.1°C Mean flow (75%) in MCN during hot months (Jul to Aug) = 135,142 kcfs. Extreme low flow or high temperature years would continue to result in mortality events.	Mean temperature (Jul to Aug) = 21.1°C Mean flow (75%) in MCN during hot months (Jul to Aug) = 135,142 kcfs. Extreme low flow or high temperature years would continue to result in mortality events.	Mean temperature (Jul to Aug) = 21.1°C Mean flow (75%) in MCN during hot months (Jul to Aug) = 135,142 kcfs. Extreme low flow or high temperature years would continue to result in mortality events.	Mean temperature (Jul to Aug) = 21.1°C Mean flow (75%) in MCN during hot months (Jul to Aug) = 135,142 kcfs. Extreme low flow or high temperature years would continue to result in mortality events.	Mean temperature (Jul to Aug) = 21.1°C Mean flow (75%) in MCN during hot months (Jul to Aug) = 135,142 kcfs. Extreme low flow or high temperature years would continue to result in mortality events.	2015 elevated temperatures cased higher mortality of fish below MCN. Did not see those mortalities above MCN. Use 2015 data to test this assumption. Recent, increased number of adult die-offs due to stress during high temperatures (female attrition coupled with thermal stress).
Flows relationship to early recruitment. Hatched larva need to be distributed to suitable habitats. Without flow risk, of failure increases.	–	–	–	–	–	–	Colville Tribes a good source for this information.
Food sources – linked to reservoir productivity.	Reservoir productivity – taken from water quality matrix at MCN pool ~ surrogate for system productivity.	Carlson TSI: mesotrophic or eutrophic; limited data. Under the NAA, MCN pool is productive and has adequate food sources for white sturgeon.	No change from NAA.	No change from NAA.	Productivity and food resources would be reduced during breach and until new equilibrium established.	No change from NAA.	Foods – white surgeon have a seasonal diet; crayfish, clams, and shad are important prey. Sockeye salmon are seasonally important and may vary from pool to pool. They are opportunistic and likely prey switch with availability (see food source notes from lower river analysis). Water quality qualitative matrix 7-11.
Recreational fisheries can stress WS and compound stress from heat and other services. Catch and release fishery from PRD to CHJ. Harvest of two 43-inch to 54-inch fish annually below PRD.	Harvest/hooksing mortality.	Catch and release angling hooking mortality is ~3%. Harvest in MCN pool = 2 fish per year between 43 and 54 inches. A limited number of white sturgeon would be harvested and/or killed from hooking mortality under the NAA.	No difference from NAA.	No difference from NAA.	No difference from NAA.	No difference from NAA.	The measure is not affected by any of the alternatives and should be removed from the analysis.

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Okanogan sockeye runs (>500,000 fish in the run – most died before reaching MCN in 2015) could possibly interact with temperatures on stressed which sturgeon. Large consumption of sockeye and high temperatures led to mortality, as WS were stressed with high metabolic requirements. 2015 mortality event in the JDA pool. Appears to be more prevalent below MCN.	Temperatures in MCN and PRD pools, sockeye runs, exceedance of 21°C.	Percent of days temperature is over 21°C. MCN tailwater = 9.7% PRD tailwater = 1.3% Under current conditions, mean high temperatures (>21°C) will occur nearly 10% of the year at MCN and only about 1% of the year at PRD. High temperatures have been linked to juvenile mortality and adult stress (Hildebrand, 2016). Current high temperatures will have minor negative effects to white sturgeon.	Percent of days temperature is over 21°C. MCN tailwater = 9.7% PRD tailwater = 1.3% High temperatures under MO1 would not differ from the NAA.	Percent of days temperature is over 21°C. MCN tailwater = 9.2% PRD tailwater = 2.1% High temperatures under MO2 would not differ from the NAA.	Percent of days temperature is over 21°C. MCN tailwater = 9.0% PRD tailwater = 1.6% High temperatures under MO3 would not differ from the NAA.	Percent of days temperature is over 21°C. MCN tailwater = 9.6% PRD tailwater = 3.1% There would be a slight increase in the occurrence of high temperatures above MCN. There would be a minor increase in risk of mortality to white sturgeon under MO4.	High temps can interact with huge sockeye runs to increase mortality events. In warm temperatures, sturgeon are unable to metabolize efficiently. Similar issues in the Fraser River. Temperatures greater than 70°F and large sockeye run in 2015, large mortality events, and sockeye in sturgeon samples. Specific pools were more affected than others, could be related to temperatures or numbers of sockeye. Routinely high 20°C to 21°C in pools in late summer, but in 2015 was early to mid-Jul, much earlier than normal, and sockeye population may be a factor.
Northern Pikeminnow							
Prefers slow water in lakes and rivers. Riverine habitats favor native species.	Water velocity	Except for the Hanford Reach, water velocities are slowed behind a series of mainstem dams. Under the NAA, northern pikeminnow will continue to have slow-moving reservoir forebays to thrive in.	No difference from NAA.	No difference from NAA.	No difference from NAA.	No difference from NAA.	Water velocity shows relatively little change within the alternatives. Recommend deleting this metric, as it does little to help in the decision process. Northern pikeminnow morphology and physiology are adapted to allow for a sustained swimming performance in fast currents. Pikeminnow can swim against currents of 115 cm/sec, for an average time of 28 minutes before becoming fatigued (Mesa and Olson, 1993).

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Affected Environment Important Relationships/Criteria	Affected Environment Metric	Environmental Consequences NAA	Environmental Consequences MO1	Environmental Consequences MO2	Environmental Consequences MO3	Environmental Consequences MO4	Notes
Spawn in rivers and lakes with gravel and cobble substrates. Northern pikeminnow are spring spawners (Apr to Jun). These fish spawn over cobble gravel substrates primarily in tailraces.	Substrate composition.	Currently, the Hanford Reach and project tailraces provide a wide range of spawning substrates that provide adequate spawning habitat for northern pikeminnow. Spawning substrate is not a limiting factor for northern pikeminnow populations. Under the NAA, the Hanford Reach and project tailraces would provide adequate spawning substrates for northern pikeminnow in the mainstem Columbia River.	No difference from NAA.	No difference from NAA.	No difference from NAA.	No difference from NAA.	Alternatives do little to alter the spawning habitats of northern pikeminnow. Recommend deleting this metric as it does little to help in the decision process. In the lower Columbia reservoirs, northern pikeminnow migrated upriver to spawn in the fast water below a dam or into a tributary stream when the temperature reached 14°C in Jun or Jul (Gadomski et al., 2001). They broadcast adhesive eggs over gravel, cobble, or rubble substrate.
Spawn above 14°C, temperatures induces spawning. Alternative changes could change spawn timing.	Temperature in reservoir tailrace (mean date reaching temperatures reach 14°C in PRD tailwater).	Water temperatures at PRD reach 14°C on average by May 31. Under the NAA, northern pikeminnow would have adequate water temperature to induce spawning by May 31.	Water temperatures at PRD reach 14°C on average by May 31. No change from NAA.	Water temperatures at PRD reach 14°C on average by May 31. No change from NAA.	Water temperatures at PRD reach 14°C on average by May 31. No change from NAA.	Water temperatures at PRD reach 14°C on average by May 31. No change from NAA.	Alternatives do little to alter the spawning habitats of northern pikeminnow. Recommend deleting this metric as it does little to help in the decision process.
Juveniles rear along shorelines where shallow water provides forage and low velocities at temperatures > 15°C.	Shoreline habitat available and temperatures over 15°C. Number of days with surface temperatures >15°C at PRD from Jun through Oct.	81% of all days during rearing Jun to Oct >15°C. Northern pikeminnow would have adequate rearing temperatures and habitats for 81% of the rearing period.	84% of all days during rearing June to Oct >15°C. Under MO1, there would be a minor increase in the number of adequate rearing days vs NAA.	82% of all days during rearing June to Oct >15°C. No change from NAA.	82% of all days during rearing June to Oct >15°C. No change from NAA.	83% of all days during rearing June to Oct >15°C. Under MO4, there would be a minor increase in the number of adequate rearing days vs NAA.	–
Food source – larval and juveniles feed primarily on invertebrates.	Invertebrate populations/use productivity from water quality team as surrogate.	MCN is mesotrophic to eutrophic. Under the NAA, the Columbia River (MCN pool) is considered moderately productive, and would provide adequate invertebrate and zooplankton populations.	Warmer August could lead to species shift in zooplankton, but could also have more growth in summer. This would lead to slight increase in food resources for larval and juvenile northern pikeminnow.	No change from NAA.	TN and TP concentrations will increase during a breach and likely for some time after. All concentrations will reflect inflows after system equilibrates. Productivity will be depressed during breach and until new equilibrium is established in MCN and would have a minor negative impact on northern pikeminnow in this pool.	No change from NAA.	–

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Affected Environment Important Relationships/Criteria	Affected Environment Metric	Environmental Consequences NAA	Environmental Consequences MO1	Environmental Consequences MO2	Environmental Consequences MO3	Environmental Consequences MO4	Notes
Harvest and sport fish reward program is the major influence on populations, continuation of sport reward program. Reward program targets 10% to 20% of the pikeminnow population.	Northern pikeminnow exploitation rates	Currently, the northern pikeminnow sport fish reward program removes 10% to 20% average of 12.7% exploitation. Continuation of the sport fish reward program would remove ~ 12.7% of adult northern pikeminnow.	No change from NAA.	No change from NAA.	Under a breach scenario, there would likely be a slight reduction in productivity in the MCN pool during breaching, with slow return of productivity. Anglers may see a slight reduction in harvest of NPM.	No change from NAA.	Pikeminnow control program has reduced number in recent years. Use population data from Hanford reach or upper Snake reaches to estimate in more natural habitat.
Abundant juvenile shad provide forage for pikeminnow in MCN pool.	Shad populations	–	–	–	–	–	Cannot find references that support this. Recommend removing this relationship.
Siberian prawns are important food source. Sontag, 2013	Qual – effects to prawns	–	–	–	–	–	Cannot find reference that supports this. Not in Sontag 2013. Recommend removing this relationship.
Juvenile salmon as food source, 70% fall Chinook salmon annually lost to predation bottleneck in MCN to PRD reach (McMichaels et al., 2017). Northern pikeminnow switch to smolt diet when they begin migrating (Shively et al., 1996).	Relative abundance of juvenile salmon and steelhead available to northern pikeminnow. Survival estimates from each alternative RIS to BON. Assume a long-term increase in survival = a long-term increase in smolts.	Under the NAA, upper Columbia Chinook survival is estimated at 0.695 and upper Columbia steelhead survival is estimated at 0.658. Under the NAA, juvenile salmon and steelhead would continue to survive at current rates. Forage in the form of smolts for northern pikeminnow is not likely to change.	Under MO1, Chinook survival is estimated at 0.700 and steelhead survival is estimated at 0.656. No change from NAA.	Under MO2, Chinook and steelhead survival are estimated at 0.682 and 0.634, respectively. Under MO2, there would be a minor reduction in smolt survival in the upper Columbia River that may lead to a reduction in foraging success of northern pikeminnow.	Under MO3, Chinook and steelhead survival are estimated at 0.701 and 0.656, respectively. No change from NAA.	Under MO4, Chinook and steelhead survival are estimated at 0.710 and 0.661, respectively. Minor increase in smolt survival would likely lead to an increase in forage for northern pikeminnow during outmigration of juvenile salmon and steelhead.	Shively et al. (1996) determined the food habits of northern pikeminnow in the Clearwater/Snake Rivers before and after the release of 1.1 million Chinook salmon smolts from Dworshak National Fish Hatchery. Prior to the release, northern pikeminnow consumed 38 % crayfish, 26% insects, 19% non-salmonid fish, and 16% wheat kernels. Twenty-four hours after the release, northern pikeminnow consumed 54% juvenile salmonids, 7% crayfish, 9% insects, 4% other, and 22% wheat kernels. Seven days after release, juvenile salmonids comprised 86%, crayfish 5%, and wheat kernels 5% of the diet.

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Affected Environment Important Relationships/Criteria	Affected Environment Metric	Environmental Consequences NAA	Environmental Consequences MO1	Environmental Consequences MO2	Environmental Consequences MO3	Environmental Consequences MO4	Notes
Water temperatures increase metabolic rates and predation of pikeminnow. Cooler, longer would decrease metabolic rates of pikeminnow, warmer, earlier increase rates.	Cumulative temperature at PRD for Apr to Jun and percent days over 12°C.	1072 cumulative temperature and 54.1% of all days Apr to Jun > than 12°C. Pikeminnow would continue to be actively feeding while juvenile salmonids are present, becoming most active in mid-May (May 13).	1071 cumulative temperature and 53.3% of all days Apr to Jun > than 12°C. No change from NAA.	1072 cumulative temperature and 53.8% of all days Apr to Jun > than 12°C. No change from NAA.	1073 cumulative temperature and 53.6% of all days Apr to Jun > than 12°C. No change from NAA.	1070 cumulative temperature and 53.3% of all days Apr to Jun > than 12°C. No change from NAA.	If cool for longer periods, fall Chinook salmon could outmigrate before increased feeding by pikeminnow. Trigger temperature for pikeminnow ~ 12°C metabolic rates increase and consumption goes up (Peterson and Ward, 1999). No difference in effects from alternatives on temperature Apr to Jun. Recommend deleting this metric.
CHJ to PRD pikeminnow targeted removal program is used to control populations. Exploitation rates relate to northern pikeminnow population levels.	–	Under the NAA, the PUDs would likely continue the removal of northern pikeminnow from the Columbia River.	No change from NAA.	No change from NAA.	No change from NAA.	No change from NAA.	PUDs have a targeted pikeminnow removal program. The PUDs currently use set lines, seines (a net that hangs vertically in the water), traps, and angling tackle to remove northern pikeminnow and increase the overall survival of migrating juvenile salmonids. No change in metric from alternatives. Recommend removing the metric.
Walleye							
Walleye populations favored by reservoir environments (temperatures and slower velocities). Outside the Hanford Reach, PUD reservoirs currently slow water to less than half a foot per second. Walleye populations are well established.	Number of walleye and qualitative discussion of habitat.	Outside the Hanford Reach, PUD reservoirs currently slow water to less than half a foot per second. Walleye populations are well established, estimated at ~ 15,000 in MCN transition (McMichael, 2018).	No change from NAA.	No change from NAA.	No change from NAA.	No change from NAA.	McMichael estimated ~ 15,000 walleye in the MCN pool in 2018. See paper for trend data. This metric does not detect differences in the alternatives, but is a statement of status.
Spawn in spring, 4°C to 10°C over benthic habitats less than 10 feet deep. Gravel or cobble substrates are best. Prefer slow-moving rivers or lakes with wave action to clean substrate.	Qual of shoreline habitat available. Miles of riprap. Date temperatures reach 4°C and 10°C at PRD and MCN.	PRD at 4°C Mar 8 and 10°C Apr 30. Substrate not likely a limiting factor. MCN at 4°C on Mar 3 and 10°C on Apr 26. Under the NAA temperatures will be suitable to induce walleye spawning from Mar 8 to Apr 30.	PRD at 4°C on Mar 8 and 10°C May 1. No change in substrate is expected. MCN at 4°C on Mar 3 and 10°C on Apr 26. No change from NAA.	PRD at 4°C on Mar 7 and 10°C May 1. No change in substrate is expected. MCN at 4°C on Mar 3 and 10°C on Apr 25. No change from NAA.	PRD at 4°C on Mar 8 and 10°C Apr 30. MCN at 4°C on Mar 2 and 10°C on Apr 25. Substrate in MCN pool will be altered as sediment is released from the Snake River Dams. There will be short-term losses of suitable spawning substrate on the south shore of MCN pool for an unknown distance downstream from the Snake River confluence. This sediment should be redistributed over time.	PRD at 4°C on Mar 8 and 10°C May 2. No change in substrate is expected. MCN at 4°C on Mar 3 and 10°C on Apr 26. No change from NAA.	NWPPC, 2004, Volume III, Chapter 7, Walleye.

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Affected Environment Important Relationships/Criteria	Affected Environment Metric	Environmental Consequences NAA	Environmental Consequences MO1	Environmental Consequences MO2	Environmental Consequences MO3	Environmental Consequences MO4	Notes
Flow and temperature can affect walleye recruitment. Walleye recruitment is best when water temperatures are above 6°C.	Flows and temperatures at PRD. Lack of flows and low temperature (below 6°C) would limit recruitment days below 6°C Mar to May at PRD.	35.0% of days below 6°C in Mar to May at PRD. Current regime of flow and temperatures will continue to support high recruitment and growth of walleye fry on ~ 65% of days in the rearing period.	35.3% of days below 6°C in Mar to May at PRD. No change from NAA.	34.8% of days below 6°C in Mar to May at PRD. No change from NAA.	34.8% of days below 6°C in Mar to May at PRD. No change from NAA.	35.0% of days below 6°C in Mar to May at PRD. No change from NAA.	Certain flow conditions and temperature conditions result in widely varying success of recruitments, but don't know what those are. Alternatives do not change this metric. Recommend deleting.
Fry are pelagic, feed on zooplankton, and switch to insects and a fish diet at about 8 weeks.	Production zooplankton abundance Apr through May.	Zooplankton levels for PRD are relatively low compared to the lower Columbia and Snake Rivers. PRD = 0-200/m3 versus IHR and JDA at 10X that amount. The lower Snake and Columbia Rivers have higher densities of zooplankton and would provide better rearing habitat than PRD	No change from NAA.	No change from NAA.	Zooplankton in MCN would be depressed during breaching of the lower Snake River dams until a new equilibrium was established.	No change from NAA.	Emerson et al., 2015
Juveniles can be limited by flows that transport juveniles to less advantageous areas. Mechanism: drop in forebay elevation moves increased flows could flush juvenile walleye out of rearing areas in the Yakima Delta and into the main channel where more susceptible to predation.	MCN forebay elevation drops Apr through Jun.	Water elevations are not currently manipulated at MCN pool during the Apr through Jun timeframe. No impacts to larval walleye are expected.	No change from NAA.	No change from NAA.	No change from NAA.	Under MO4, water elevations would be dropped by 1 foot on average years in mid-Apr on dry years hey could be dropped by as much as 3.5 feet in mid-May. These conditions may reduce survival of larval walleye that would be flushed from nursery areas.	Juveniles rearing in Yakima could manipulate flows at MCN. Potential drop 5 feet for 24 hours to flush the juveniles out of bays, then raise back to normal. Walleye rearing - 15°C and higher – Apr to Jul. Potential negative impact to navigation barge traffic MCN to ICH. Note: also potential effect to fall Chinook fry.
Adults avoid light and prefer deeper water.	Qualitative description of deep water habitat available.	Depth data will show there is adequate depth for walleye. Under the NAA, walleye will continue to have deep water habitat available.	No change from NAA.	No change from NAA.	No change from NAA.	No change from NAA.	As they grow older, walleye avoid light. They migrate offshore into deep water during the day and onshore at twilight (Scholz et al., 2014). None of the alternatives has an effect on water depth for the project area. Recommend removing this as a metric for selection.
Walleye juveniles and adults exhibit the best growth in water temperatures between 20°C and 24°C (Barton and Barry, 2011).	Percent of days water temperature is over 20°C at MCN pool mid forebay.	17.6% of all days over 20°C. Best growth for walleye occurs on about 17% of the days of an average year.	17.9% of all days over 20°C (~1 day warmer). No change from NAA.	17.7% of all days over 20°C (<1 day warmer). No change from NAA.	17.7% of all days over 20°C (<1 day warmer). No change from NAA.	17.3% of all days over 20°C (<1 day cooler). No change from NAA.	None of the alternatives has a significant effect on water temperatures in this reach. Recommend removing this metric from selection.

Affected Environment Important Relationships/Criteria	Affected Environment Metric	Environmental Consequences NAA	Environmental Consequences MO1	Environmental Consequences MO2	Environmental Consequences MO3	Environmental Consequences MO4	Notes
Smallmouth Bass							
Smallmouth bass are nest spawners, so flow fluctuations can impact nesting success. Stable flows when temperatures trigger spawning, followed by a drop in flows could desiccate nests.	Water elevation Apr to Jun at MCN pool.	MCN water elevations will remain fairly constant at 338.7 feet in most years, with a 1-foot operating range, which is not likely to impact smallmouth bass nesting success.	No change from NAA.	No change from NAA.	No change from NAA.	Measure O8 allows for a drawdown of 1 foot in average years. In the driest years, there may be a drawdown of 3.5 feet, which would reduce nesting success of smallmouth bass on the driest years.	Study would be needed to know if it would be effective. Spawning dates for smallmouth bass are temperature driven (Edwards et al., 1983).
Temperature at spawning: 12°C to 15°C triggers spawning (Scholz et al., 2014).	Temperatures in MCN. Date that they first exceed 12°C (surface temperatures.	Data surface water at MCN reaches 12°C ~ May 3. Under the NAA, smallmouth bass spawning may be initiated as early as May 3 on an average year.	Surface water at MCN reaches 12°C on May 2 – one day earlier than NAA on average. No change from NAA.	Surface water at MCN reaches 12°C on May 2 – same day as NAA on average. No change from NAA.	Surface water at MCN reaches 12°C on May 1 – two days earlier than NAA on average. May be slightly earlier spawn under MO3 with early warming.	Surface water at MCN reaches 12°C on May 2 – same day as NAA on average. No change from NAA.	Smallmouth bass spawn in Apr and May in the Columbia River (Wydoski and Whitney, 1975). Early spawning (Apr and May) could be unsuccessful if followed by high flows that reduce temperatures and induce nest failure. Smallmouth bass migrate into the Yakima and spawn in May of each year.
Flows and temperature relationships – increased flows after spawning could decrease water temperatures (influx of cooler water). If smallmouth bass have already spawned and then get cooler males may abandon the nests, resulting in recruitment failure.	Flows at MCN and PRD after temperatures reach 12°C – May 3 on average for the NAA.	Temperatures to induce spawning would occur May 3 on average, while flows reach their peak at MCN in early June. Under the NAA, smallmouth bass are expected to abandon nesting on an unknown number of years.	Temperatures to induce spawning would occur May 3 on average, while flows reach their peak at MCN in early June. No change from NAA.	Temperatures to induce spawning would occur May 3 on average, while flows reach their peak at MCN in early June. No change from NAA.	Temperatures to induce spawning would occur May 3 on average, while flows reach their peak at MCN in early June. There is a greater likelihood for early heating and cooling in MO3, which would slightly increase the risk of nest failure of smallmouth bass under this alternative.	Temperatures to induce spawning would occur May 3 on average, while flows reach their peak at MCN in early June. No change from NAA.	Look at MO data for decrease in water temperature after reaching 55°F.
Diet, food source dynamics? See McMichaels, 2018).	Forage base changes in the Hanford Reach and MCN poo.	Changes in prey items are dependent on salmon availability. Large numbers of up upper Columbia Chinook are consumed by smallmouth bass that rely heavily on juvenile salmon during spring outmigration. Under the NAA juvenile salmon and steelhead will continue to be an important part of smallmouth bass diets during the spring outmigration. Smallmouth bass will switch to sculpin and crayfish as salmon numbers decline.	No change from NAA.	No change from NAA.	Productivity will likely be depressed during breach and for some time offer earl	–	Sandrollers are a dominant food source when no salmon are available. Up to 35% of smallmouth bass diet was comprised of sandrollers in a 2014 study (Sontag, 2014), but later study estimated high salmon predation (Erhardt et al., 2018).

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Affected Environment Important Relationships/Criteria	Affected Environment Metric	Environmental Consequences NAA	Environmental Consequences MO1	Environmental Consequences MO2	Environmental Consequences MO3	Environmental Consequences MO4	Notes
Optimal temperature range for adult rearing is 21°C to 27°C (Edwards, 1983).	Percent of days temperatures are over 21°C at MCN pool – surface.	13.5% of all days over 21°C ~ 49 days per year. Current conditions provide ideal rearing conditions for smallmouth bass at MCN pool for ~ 49 days a year.	14.8% of all days over 21°C ~ 54 days a year. Under MO1, there would be a minor increase in days of higher temperatures and ideal rearing conditions for smallmouth bass than the NAA.	13.5% of all days over 21°C ~ 49 days a year. No change from NAA.	13.2% of all days over 21°C ~ 48 days a year. No change from NAA.	14.4% of all days over 21°C ~ 53 days a year. Under MO4, there would be a negligible increase in days of higher temperatures and ideal rearing conditions for smallmouth bass than the NAA.	Edwards et al. (1983) gave the upper temperature limit for adult smallmouth bass a 30°C, the optimum range for adult rearing as 21°C to 27°C, and the optimum range for spawning as 12.8°C to 21°C.
Turbidity can limit smallmouth bass growth and feeding success,	Turbidity levels during outmigration Apr through Jun.	Turbidity is dependent on water flow year and land use practices. Currently, sediment levels are approximately 2 mg/l. Under the NAA, turbidity will not change from current conditions. High water years will likely limit smallmouth bass growth.	No change from NAA.	No change from NAA.	Significant increase during breaching and for several years after depending on erosion rate of deposited materials. Subsequent amounts dependent on watershed land-use practices and runoff events. May decrease foraging efficiency of smallmouth bass during this timeframe.	No change from NAA.	Data was insufficient to do quantitative analysis of turbidity (Water Quality Appendix, 7-11). Sontag (2014) showed that highly turbid waters reduced foraging success of smallmouth bass and consumption of smolts, while Erhardt et al. found that, under clear water conditions, smallmouth bass have improved foraging success and smolt composition.
Adults go inactive at temperatures less than 10°C.	Water temperatures less than 10°C at MCN pool dates above and below and percent of days inactive.	Apr 24 is first day over 10°C. Nov 15 is last day over 10°C (55.8% or 204 days active). Under the NAA, smallmouth bass would have ~ 204 days of water temperatures over 10°C or 204 days when they would be active.	April 26 is first day over 10°C. Nov 15 is last day over 10°C (56.0% or 204 days active). No change from NAA.	Apr 25 is first day over 10°C. Nov 15 is last day over 10°C (56.2% or 205 days active). No change from NAA.	April 23 is first day over 10°C. Nov 15 is last day over 10°C (55.4% or 202 days active). Under MO3, there is likely a shift in smallmouth bass activity forward in the calendar year by a couple days and a decrease of 2 days in activity. Not likely a significant change for smallmouth bass.	Apr 25 is first day over 10°C. Nov 15 is last day over 10°C (56.0% or 204 days active). No change from NAA.	–
High turbidity displaces from (2,000) JTU.	Turbidity levels during outmigration May through Jun.	Turbidity is dependent on water year and land use practices, but will generally be highest during the spring runoff on high water years. Under the NAA turbidity will not change from current conditions and will limit fry survival in high water years.	No change from NAA.	No change from NAA.	Turbidity will experience a significant increase during breaching and for several years after depending on erosion rate of deposited materials. Subsequent amounts dependent on watershed land-use practices and runoff events. Highest sediment levels will occur after juvenile rearing season is over, but may decrease rearing success during high water events following breaching.	No change from NAA.	–

Affected Environment Important Relationships/Criteria	Affected Environment Metric	Environmental Consequences NAA	Environmental Consequences MO1	Environmental Consequences MO2	Environmental Consequences MO3	Environmental Consequences MO4	Notes
Native Fish Community							
Mountain whitefish is strong fishery in the fall, and top bycatch for salmon and steelhead anglers. Feed heavily on fall Chinook salmon eggs in the fall.	See northern pikeminnow.	–	–	–	–	–	–
Game Fish							
Other game fish include crappie, perch, bluegill, and largemouth bass. Most do not occur in great numbers, particularly in the Hanford Reach. Alternative sources of game fish include inputs from irrigation water returns. Largest concentrations are in reservoir pools where MCN has the highest concentrations.	–	–	–	–	–	–	–

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3.8.4 Region C

3.8.4.1 Snake River Basin

Table 3-80. Snake River Resident Fish Qualitative Effects Analysis Matrix

Affected Environment Important Relationships/Criteria	Affected Environment Metric	Environmental Consequences NAA	Environmental Consequences MO1	Environmental Consequences MO2	Environmental Consequences MO3	Environmental Consequences MO4	Notes
Bull Trout							
Cold water required, >15°C limits distribution.	Water Temperatures in FMO habitat (number of days above 15°C - 80 year POR) Taken at LGS - most bull trout counts.	Water Temperature regime in reservoirs similar to current. Temperatures currently supports FMO habitat when bull trout are present. Temperature exceeds 15°C degrees only 0.3% (54 of 16939 days) of the time from Nov through May. June through Oct temps exceed 84.6% (10,324 of 12209 days) of the time. Year round temps exceed 15°C 35.6% (10378 of 29149). Low numbers of bull trout would continue to use Snake River reservoirs and river as forage, migration, and overwinter habitat as temperatures allow (primarily November through June).	Temp exceeds 15°C only 0.3% (54 of 16939 days) of the time from Nov through May. June through Oct temps exceed 84.2% (10,283 of 12209 days) of the time. Year round temps exceed 15°C 35.5% (10337 of 29149). No difference from NAA. Warmer temperatures are seen in August under MO1 from altered cooling flows should not impact bull trout in the Snake as they are in tributaries at that time. Could be subadults holding in cold water refuge at the Clearwater that may be negatively impacted by August flow reduction. Check Temperatures Downstream for hot water.	Temp exceeds 15°C only 0.3% (54 of 16939 days) of the time from Nov through May. June through Oct temps exceed 85.3% (10,414 of 12209 days) of the time. Year round temps exceed 15°C 35.9% (10467 of 29149). Summer Temps would be slightly warmer, but bull trout are not expected to be in the system in large numbers at that time. No difference from NAA.	Temp exceeds 15°C only 0.4% (65 of 16950 days) of the time from Nov through May. June through Oct temps exceed 76.5% (9,341 of 12209 days) of the time. Year round temps exceed 15°C 32.7% (9405 of 29159). Because of smaller water body (less thermal inertia) overall temperatures would be cooler and more suitable for bull trout except in June and July. There would be minor impacts to Bull trout in the system in June and July (reduced stress and survival) but remainder of the time they occur in mainstem would be cooler and more suitable for bull.	Temp exceeds 15°C only 0.3% (54 of 16939 days) of the time from Nov through May. June through Oct temps exceed 84.8% (10,348 of 12209 days) of the time. Year round temps exceed 15°C 35.7% (10402 of 29149). No difference from NAA.	Few bull trout in Snake River during late summer and early fall months when there are temperature limitations. Bull trout most often seen at projects April through June, but have been recorded in the mainstem nearly every month of the year. Water temps influenced by warm Brownlee outflows. Hells Canyon relicensing could result in changes important for cumulative effects. May draft if predicting 16.5°C by October, so takes less time for cool water out. Won't exceed 16.5°C. Would result in cooler temp inflows to lower Snake River projects. Barrow et al., 2016
Mainstem passage seen as limiting to bull trout migration.	Number of bull trout passing through ladders and Separators	(2006-2014) IHR <1 BT/year; LGR ~ 3 BT/year; LMO ~ 17 BT/year; LGS = 50 BT/year Checked PTAGIS = Limited data matches relative abundance at dams. Bull trout found passing SR projects in low numbers. Would continue to pass in the future. Seen at projects primarily in Apr to Jun when they are leaving the mainstem for cooler waters.	No difference from NAA.	Bull trout would continue to pass projects in limited numbers. However, the team expects reduced survival under this alternative as a higher portion of fish would pass via turbine routes. This passage route generally has lower survival.	Long term impacts: Removal of four lower Snake River dams would reduce any delays in passage. High flows may cause seasonal velocity barriers for bull trout at dam sites where velocities may reach over 12 feet/second. Dams may provide foraging areas for adult bull trout during outmigration. During breach there may be short term passage issues at tributary mouths. Fish come to mainstem and cannot reascend.	No difference from NAA. Additional spill may cause delays in bull trout passage at dams in May and June when they are moving out of the system to avoid temps.	SNAKE RIVER DAMS passage, operates except for Jan 1 to Feb 28. Bull trout do get past the projects, but may get entrained downstream to some extent. Use ladders except when closed. Barrow et al., 2016

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Entrainment – bull trout can get entrained at Snake River run-of-river dams. Populations tend to be moved downstream and not move back up (i.e., Asotin fish are seen below LGR, but few see back up at Asotin).	Number of tagged bull trout passing dams in ladders or bypass systems.	6 of 9 bull trout tagged in the Tucannon River were seen at dams downstream from the Tucannon river. However, genetic studies show fish moving down the system from above Tucannon with Tucannon genetics. Bull trout would continue to be entrained in low numbers. Because of low numbers in the system effects are not likely significant.	No difference from NAA.	Bull trout would continue to pass projects in limited numbers. However, we expect reduced survival under this alternative as a higher portion of fish would pass via turbine routes. This passage route generally has lower survival.	Long-Term Benefit. Improved passage for bull trout moving up or downstream. Short term impacts to fish as they try to reascend rivers in the spring and find they are perched.	No known relationship between spill and attraction for bull trout. Potential for additional delay and fallback with higher spill.	Tucannon and Walla Walla River Bull Trout have been tracked downstream and most appear lost through entrainment. Some Imnaha fish are seen in Asotin Creek and some also dipped into LGR and back up multiple times through the ladder. Ladders not designed for bull trout, but they pass. Note: Idaho Power entrainment plan under development in relicensing process; (cumulative effects). Note: while higher spill alts could result in higher fallback in spring and summer, there would be no spill in winter. There is a lack of data to support this and low numbers of fish in the system.
Dworshak entrainment – in colder parts of the year, bull trout further down in the reservoir could be entrained.	Entrainment relationship	Literature and discussions with Corps staff indicate this is not an issue at Dworshak. No effect. No need to discuss.	No difference from NAA.	No difference from NAA.	No difference from NAA.	No difference from NAA.	Potentially an issue in winter. Ask Paul Pence. Relationship discussed in SOR. Recent discussions indicate no issue with this.
Migration access to mainstem habitat. LMO and IHR connect Walla Walla and Tucannon sub-basins.	Bull trout movement data	Corps data shows limited numbers of bull trout accessing FMO mainstem habitats. Bull trout migrate to FMO habitat in November and December, then back to tributaries in Mar to May. Count data in winter is limited. Low numbers of bull trout will continue to use mainstem FMO habitats. Some movement between populations will continue.	Low numbers of bull trout will continue to use mainstem FMO habitats. Some movement between populations will continue. No Change from NAA	Low numbers of bull trout will continue to use mainstem FMO habitats. Some movement between populations will continue. However, the team expects reduced survival under this alternative as a higher portion of fish would pass via turbine routes. This passage route generally has lower survival.	Long term benefit from removal of 4 lower Snake River dams would improve connectivity of Bull trout populations. Short term impacts to fish as they try to reascend rivers in the spring and find they are perched.	Low numbers of bull trout will continue to use mainstem FMO habitats. Some movement between populations will continue. Additional spill may cause delays in bull trout passage at dams in May and June when they are moving out of the system to avoid temps.	Larger bull trout that use the SR are drivers of the population. These fish are generally more productive and more mobile. The loss of these larger, fluvial fish from the community could drive a change in the community structure. Some Tucannon fish using SR, down, then up to Walla Walla. Movement primarily downstream. Jarbridge study - Even when bull trout wander, they tend to remain genetically very distinct. In St. Mary - some did move between spawning tributaries and spawn at the new site. (Mogen et al. 2005).

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Forage for bull trout in lower Snake River – need adequate forage for migrating juvenile and adult bull trout.	Forage Fish/Smolt Numbers	See other species tabs in this sheet and the anadromous fish. Currently, relatively high numbers of juvenile salmonids in the system when bull trout are migrating (Nov-June). Peak numbers in the SR occur in Apr-Jun. Siberian Prawns may provide additional forage (Tiffen et al. 2017). Healthy populations of forage fish for bull trout would continue to be available to support migratory bull trout.	Healthy populations of forage fish for bull trout would continue to be available to support migratory bull trout. No change from NAA	Healthy populations of forage fish for bull trout would continue to be available to support migratory bull trout. No change from NAA	Temporary reduction 2 to 7 years in forage for bull trout would be expected as a result of breaching (River Mechanics Modeling – 2 to 7 years to clean embedded cobble for invertebrate use). Forage fish and invertebrates would be expected to increase over time after initial sediment pulses. Change from zooplankton to macroinvertebrates. would benefit juvenile and subadult bull trout.	Healthy populations of forage fish for bull trout would continue to be available to support migratory bull trout. No change from NAA	Forage base has increased with introduced species under the NAA. Low numbers of salmon smolts available for bull trout forage in tributaries. Alternatives the increase smolt production are expected to increase forage for adult and sub-adult bull trout.
Forage in Dworshak.	Forage Fish	Are forage fish populations stable or increasing? Is there data to support this?	–	–	–	–	Look at potential to affect forage base through operations. This metric did not appear useful in detecting differences in the alternatives and was discarded.
Predation – potential predation by catfish, walleye, or smallmouth bass is probably a minor issue. Competition more of an issue because, with more predators, there is more competition. Warmer temperatures are generally associated with a higher risk of predation.	Populations of predators and Water Temperature (Alternatives with higher temperatures would be associated with higher risk of predation).	Numbers of Walleye have increased, Northern Pikeminnow are down, while Catfish and SMB are relatively abundant. Temp exceeds 15°C only 0.3% (54 of 16939 days) of the time from Nov through May. June through Oct temps exceed 84.2% (10,283 of 12209 days) of the time. Year round temps exceed 15°C 35.5% (10337 of 29149). Warmer temperatures seen in August under MO1 from altered cooling flows should not impact bull trout risk to predation in the Snake as they are in tributaries at that time. No difference from NAA. Temperatures are generally cold when bull trout are in the system - Predation is not likely a significant impact to adult bull trout during winter months.	Temp exceeds 15°C only 0.3% (54 of 16939 days) of the time from Nov through May. June through Oct temps exceed 84.2% (10,283 of 12209 days) of the time. Year round temps exceed 15°C 35.5% (10337 of 29149). Warmer temperatures seen in August under MO1 from altered cooling flows should not impact bull trout risk to predation in the Snake as they are in tributaries at that time. No difference from NAA.	Temp exceeds 15°C only 0.3% (54 of 16939 days) of the time from Nov through May. June through Oct temps exceed 85.3% (10,414 of 12209 days) of the time. Year round temps exceed 15°C 35.9% (10467 of 29149). Summer Temps would be slightly warmer, but bull trout are not expected to be in the system in large numbers at that time. No difference from NAA.	Temp exceeds 15°C only 0.4% (65 of 16950 days) of the time from Nov through May. June through Oct temps exceed 76.5% (9,341 of 12209 days) of the time. Year round temps exceed 15°C 32.7% (9405 of 29159). While temperatures will not differ greatly from the NAA, predator numbers and composition are expected to be altered as a result of dam breaching. Reservoir species are likely to be less dominant while riverine species will be more prevalent. Large sediment flushes and increased BOD may reduce non-native predators during the breach and up from 2 years to 7 years. Short term reduction in predation risk followed by increases in this risk to similar pre-breaching levels.	Temp exceeds 15°C only 0.3% (54 of 16939 days) of the time from Nov through May. June through Oct temps exceed 84.8% (10,348 of 12209 days) of the time. Year round temps exceed 15 C 35.7% (10402 of 29149). No difference from NAA.	Minor effect in projects because they are used primarily in winter by adult bull trout. Not many predators on adults. (Med impact in CEM). Potentially avian predation on large adults, more susceptible in tributaries.

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Habitat degradation – bull trout require cold water environments with complex habitat. The Snake River is used for FMO habitat.	Habitat loss/Elevated TDG Days TDG over 110% from November thru June LWG	Mainstem is FMO habitat - not a limiting habitat to bull trout populations in the lower Snake River. Days over 110% Nov-Jun - 7212/19350 = 37.3% (Mean 106.1). Elevated TDG may negatively impact an unknown number of bull trout.	Days over 110% Nov-Jun - 7206/19350 = 37.2% (Mean 106.2). No difference from NAA.	Days over 110% Nov-Jun - 6530/19350 = 33.7% (Mean 105.5). Slight reduction in TDG may have minor reduction in risk of GBD in Bull trout.	Reduced TDG (104%-105%) levels would benefit bull trout. However, breaching would have an initial negative impact on water quality as sediment is released and oxygen demands increase.	Days over 110% Nov-Jun - 9354/19350 = 48.3% (Mean 111.1). Higher TDG may impact additional (vs NAA) bull trout in May and June when leaving the system. Minor increase in risk of GBD.	Habitat loss is an important factor in tributaries, but FMO habitat is not a limiting factor within the project area. Bull trout more sensitive to GBD than Chinook. McGrath et al 2006. Beeman et al. 2003.
Non-native hybridization – hybridization with brook trout can be a factor in bull trout losses.	Number of Brook trout in area of analysis.	Brook trout numbers limited in Snake river mainstem habitats. Hybridization is not a major factor in bull trout populations in the Snake River mainstem habitats.	No difference from NAA.	No difference from NAA.	No difference from NAA.	No difference from NAA.	Does not appear to be a factor in the project area.
Sediment Tolerance – during dam breach, high sediment releases are expected that could exceed bull trout tolerances.	Bull trout tolerance to high sediment loads	Input natural sediment levels in NAA. Expect current suspended sediment to remain low (2 mg/l) under the NAA (Not during runoff). Under the NAA there are no anticipated negative effects from sediment to bull trout.	No difference from NAA.	No difference from NAA.	Sediment loads may reach 25,000 mg/l for short periods of time. An estimated 26 days of sediment over 5,000 mg/l could result. However, during August thru October, limited numbers of bull trout occur in the mainstem and short term effects to bull trout are not likely to occur. Severity index for sediment shows that bull trout in the mainstem would experience an index of ~11 = 20% to 40% mortality from sediment (Newcombe and Jenson 1996). Long term impacts would include elevated sediment during the spring freshet the following year. These conditions are likely to negatively impact bull trout.	No difference from NAA.	Newcombe and Jenson 1996.

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Oxygen Tolerance – during dam breach, high sediment releases may increase BOD to levels that deplete oxygen in the system. Bull trout equilibrium is lost at 2 ppm to 3 ppm.	Bull trout tolerance to low oxygen levels (loss of equilibrium at 2 to 4 mg/l - Doudoroff and Shumway 1970)	Oxygen levels are expected to remain high during the NAA. No effect to bull trout.	No difference from NAA.	No difference from NAA.	Short term impacts: sediment loads may reach 25,000 mg/l for short periods of time and oxygen may be reduced to near 2 ppm. An estimated 26 days of sediment over 5,000 mg/l could result. Reduced Oxygen may be associated with that level of sediment. However, during August thru October, limited numbers of bull trout occur in the system and short term effects to bull trout are not likely to occur. BOD would occur after initial flush of sediment. Any bull trout in the mainstem would likely be killed. Most bull trout leave mainstem river by July.	No difference from NAA.	Water quality team discussions with USGS indicate low oxygen likely in two flushes. Chemically as sediments are released and biologically as plant and animal matter degrade.
Dworshak spawning access to tributary streams during drawdown.	Dworshak Spawning Access to tributary streams.	Bull trout upstream migration occurs primarily in May and June when the DWA pool is rising and near its peak (Hanson et al. 2006) Information from project biologists indicates that upstream passage is not likely an issue. Bull trout have access to most spawning areas under the NAA.	Under MO1 drafting for cooling/augmentation is begun sooner and could have an impact to bull trout migrating in the latter half of June.	Under MO2 drafting for power generation can reduce the pool relative to the NAA and may have an impact on bull trout migrating in May and June.	No change from NAA	No change from NAA	Talk to the Corps and Idaho Fish and Game. No known issue with current operations.

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White Sturgeon							
Migration access to extended habitat is important for population connectivity.	Fish Ladder and Bypass Numbers	Bypass Numbers by dam: LMO: 5 to 10 per year LGO: 15 to 20 LGR: 25, 0, 40 in 2018 (from enlarged orifice). PTAGIS data for sturgeon - very few hits from sturgeon on Snake River dams. 13 total PIT tagged WS were seen at the LS Dams. 11 of these were seen at Ice Harbor, but only one in the ladder. The rest in the bypass. One fish at LGR in Bypass and 1 in LGO in adult fish return Sturgeon Working Group is seeing increases in Juvenile sturgeon upstream of LGR dam (Hughes and Lepla 2018 - Idaho Power. Current populations in the IHR, LMO, and LGR are recruitment limited. These populations would continue to decline (Hildebrand, 2016) with most of the recruitment coming from upstream sources that are entrained into the lower Snake projects.	In MO1, no change is expected that would improve passage for Sturgeon. No difference from NAA.	In MO2, no change is expected that would improve passage for Sturgeon. No difference from NAA. Survival may decrease for downstream migrants as more of them are put through the turbine vs spillway.	The breaching of the lower 4 Snake River dams would reconnect white sturgeon populations from McNary to Hells Canyon. Movement between populations would be unrestricted and spawning habitat would increase. Recruitment would likely increase. Spawning habitat would likely increase from 200 to 3000 acres. Short Term effects currently include lack of connectivity.	In MO4, no change is expected that would improve passage for Sturgeon. No difference from NAA.	Currently, habitats are fragmented with limited passage at the dams. Declining populations from lack of recruitment. Potentially some spawning still happening, smaller fish from Snake River. Sturgeon adults are trapped between project structures. The Dalles ladder does have limited sturgeon movement, but lower Snake River ladders don't pass sturgeon. Sturgeon captured at juvenile bypass facilities are released downstream. There is a general downstream movement of sturgeon because they don't use ladders in current design. Potentially some bigger ones move through turbines. In both the Ice Harbor and Lower Monumental reservoirs, the age structure is skewed towards older individuals, indicating those population segments are recruitment limited. There appears to be a gradient of reduced juvenile abundance in the lower Snake white sturgeon population segments with increased downstream distance from LGR. This suggests that many of the white sturgeon in the lower Snake reservoirs may have been entrained through the dams (Hildebrand, 2016).

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Harvest or predation removes large adults. Catch and release mortality may remove a limited number of white sturgeon.	Harvest of Sturgeon	Harvest is not allowed in the Snake River, but catch and release mortality could be a minor impact (2.7%). Predation of adults is not likely to occur in this section of the river. Catch and Release mortality is estimated at ~ 3% (Robichaud et al. 2006) which may have minor impacts to white sturgeon populations. No known predators.	No difference from NAA.	No difference from NAA.	Assume no difference from NAA. May be short term effects that would require closure of the season.	No difference from NAA.	Not harvesting anymore. Harvest not affected by projects, except limited harvest below Ice Harbor. Feed this information to the Econ Team.
Juveniles need adequate forage early in life; age at first feeding is important. Movement from hatch to environment with food is critical; reservoirs provide for these fish. Larval sturgeon eat benthos, periphyton, and zooplankton.	Qualitative discussion of food resources. Lack of data for this metric.	Currently, lower Snake River reservoirs are classified as either mesotrophic or mildly eutrophic and are dominated by zooplankton communities. These resources are adequate for larval fish, but as WS grow they switch increasingly to aquatic invertebrates. Beneficial for larval fish less so for juvenile fish.	No difference from NAA.	No difference from NAA.	Long term effects: Loss of zooplankton and conversion to invertebrates. Short term effects would include loss of forage base at time of breaching. 2 to 7 Year recovery of invertebrate resources would limit recruitment and survival. Beneficial to juvenile fish less so for Larval fish.	No difference from NAA.	Larvae need Benthos, periphyton, and zooplankton. Juveniles switch to invertebrate diet. Reservoirs provide good food for larval fish, but spawning habitat is limited. Introduced shrimp, (Mysis, Siberian prawns) Mysis could provide forage. Mesotrophic to eutrophic.
TDG relationship with young sturgeon – sensitive to TDG (McGrath et al., 2006; Counihan et al., 1998; and Weitkamp, 2008).	Days from Apr 1 through Jul 31 TDG > 120%	TDG Apr through Jul number of days over 120%. High = 136% TDG; 809/9760 days over 120 = 8.3%; WQ plots show that the majority of these dates are in Jun and July. Under the NAA elevated TDG would have an adverse effect on White sturgeon for pars of June and July.	High = 136% TDG; 889/9760 days over 120 = 9.1%; WQ plots show that the majority of these dates are in Jun and July. There would be a negligible increase in exposure to high TDG and adverse effect under MO1 vs NAA.	High = 136% TDG; 660/9760 days over 120 = 6.8%; WQ plots show that the majority of these dates are in Jun and July and that there would be a moderate decrease in exposure to high TDG in the fall and a slight decrease during April through July under MO2 vs the NAA. This would improve conditions for larval White Sturgeon.	High = 104% TDG; 0/9760 days over 120 = 0%; TDG conditions would be ideal for most of the Lower Snake River under this alternative. No negative effects from TDG to white sturgeon are expected under MO3.	High = 136% TDG; 5163/9760 days over 120 = 52.9%; WQ plots show major increases in exposure to high TDG from Apr through July and moderate increases in parts of April and May when compared with the NAA. There would be negative impacts to white sturgeon fry under MO4.	TDG of 118% altered buoyancy of larval sturgeon 130% TDG 50% mortality. Fish would be more prone to predation. Larval stage is drifting stage and often in shallow water.

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Hydrology needed to cue spawning – high velocities during the descending limb of hydrograph in Apr to Jul (Hildebrand et al., 2016).	Water velocity > or = 2.6 f/s mean water column April thru June. Qualitative discussion.	Enter current flow data from HH, see summary hydrograph at LGR. Mean flows for Apr, May and Jun are 74, 100, and 102 kcfs, respectively. 12°C to 18°C. Hildebrand 2016. Water velocities are modified in reservoir areas. However, high flows are occurring in spring at tailrace locations. These locations are likely the only spawning habitat available.	No difference from NAA.	No difference from NAA.	The removal of the 4 lower Snake River dams would increase spawning habitat and produce higher velocities to induce spawning. Lower Snake River Juvenile Migration Feasibility Report (2002) estimates that spawning substrate for Chinook salmon would increase from 226 to 3,521 acres under a breach scenario. These substrates would also benefit Sturgeon. HEC RAS modeling shows that average velocities in a breached scenario would reach between 6 and 8 feet/second during the spring runoff. Average velocities for the year would be ~ 4 feet/ second compared to ~ 0.4 feet/second under the NAA. These conditions would lead to more successful spawning and recruitment for white sturgeon	High Spill may provide higher velocities in area if the tailrace and may induce spawning in more years. Check with Ryan Laughery.	Flow velocities are currently not adequate in reservoirs to induce spawning except in tailraces. Some spawning occurs, most likely in tailraces where velocities are higher. No spawning found in LGR, velocities not adequate, probably spawn upstream of LGR Reservoir. Parsley and Kappenman (2000) captured fertilized eggs. Spawning 1km below Little Goose. Juvenile gradient is indicative of entrained through dams. (Devore et al. 1999)
Temperature criteria for spawning/egg incubation. Cold water during high flow events is needed to cue spawning. Temperatures outside 8°C to 18°C show reduced egg survival; mortality >20°C (Lepla and Chandler, 2001).	Temperatures from 8°C to 18°C from Apr to Jun at IHR because of high white sturgeon population below dam.	8.2% (504/6160) of modeled days between April 15 and June 30 were above 18°C and 0.3% (21/6160) days were below 8°C. 2.7% of these days were over 20°C (168/6160). Water temperatures in the lower Snake River are suitable for egg incubation and spawning during most years. On warm years survival would be reduced.	7.9% (486/6160) of modeled days between April 15 and June 30 were above 18°C and 0.3% (21/6160) days were below 8°C. 2.6% of these days were over 20C (161/6160). No change from NAA.	8.7% (534/6160) of modeled days between April 15 and June 30 were above 18°C and 0.3% (21/6160) days were below 8°C. 3.1% of these days were over 20C (194/6160). No change from NAA.	Water Quality modeling shows that water temperatures will likely be warmer in June and July by 2 to 4 degrees and cooler September through December by the same amount. More days will likely exceed optimum temperatures for egg incubation under MO3 than the other alternatives. Earlier warming may induce adults to spawn earlier and reduce any negative impacts. Unknown impact to white sturgeon.	8.2% (505/6160) of modeled days between April 15 and June 30 were above 18°C and 0.3% (21/6160) days were below 8°C. 2.7% of these days were over 20°C (169/6160). No change from NAA.	Temperatures are suitable for sturgeon spawning in most years in the lower Snake River projects below LGR dam.

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Sturgeon are highly sensitive to in-river contaminants (selenium, methyl mercury), potential sub-lethal effects (Little et al., 2014).	Selenium, methyl mercury levels	Sampling to date did not show elevated levels of these contaminants. Sandy check sampling of sediments in reservoirs (Water Quality Appendices 7-7 thru 7-10. Sediment contaminants are not likely to affect white sturgeon populations.	WQ is not likely to change from NAA under MO1.	WQ is not likely to change from NAA under MO1.	The breaching of the lower four Snake River dams will re-entrain dormant sediments that may contain elevated concentrations of heavy metals. These metals will have an unknown impact on Sturgeon	WQ is not likely to change from NAA under MO1.	Sediment sampling for dredging, wasn't a big issue in current sampling; have not hit threshold for selenium. (Dredging EIS).
Rearing habitat – Yolk sack larvae (YSL) need cover at early life stages. Gravel substrate. The YSL need cobble gravel substrates with interstitial spaces to survive and grow well.	Substrate description in Lower Snake Reservoirs	Previous work shows gravel and cobble habitats occur primarily in the tailrace of each dam. Rearing habitat for YSL is present in tailraces of each dam. This is likely a limiting habitat in the lower Snake River.	No difference from NAA.	No difference from NAA.	Long term: The breaching of the lower four Snake River dams would likely improve habitat for both spawning and rearing. River mechanics modeling shows that current sediment deposits would likely be scoured to the original bed and restore additional gravel cobble substrates within 2 to 7 years. Short term: Release of sediments during breaching would silt cobble and gravel substrates temporarily. These would be scoured clean in 2 to 7 years. Short-term reduction in sac fry hiding cover. Long term increase in the same.	No difference from NAA.	Yolk Sack Larvae (YSL) need cobble gravel substrates with interstitial spaces to survive and grow well. Other reservoir (John Day) has gravel substrate to provide hiding cover for early life stage. Snake River reservoirs have less habitat.
Sediment Tolerance – during dam breach, high sediment releases are expected that could exceed white sturgeon tolerances.	White Sturgeon tolerance to high sediment loads	Current sediment concentrations are near 2 mg/l. Under these conditions there are no negative impacts to white sturgeon.	No difference from NAA.	No difference from NAA.	Short term impacts include Sediment loads ~ 5,000 mg/l for short periods of time. Severity rating of 11 ~ 20% to 40% mortality of white sturgeon (Newcombe and Jensen 1996). Long Term impacts: spring flushing flows the following year(s) would reactivate perched sediments and increase sediment concentrations. These concentrations may have negative impacts to white sturgeon.	No difference from NAA.	Sediment loads may reach 25,000 mg/l for short periods of time. High sediment loads may limit egg and larval survival.

Affected Environment Important Relationships/Criteria	Affected Environment Metric	Environmental Consequences NAA	Environmental Consequences MO1	Environmental Consequences MO2	Environmental Consequences MO3	Environmental Consequences MO4	Notes
Oxygen tolerance – during dam breach, high sediment releases may increase BOD to levels that deplete oxygen in the system. Equilibrium is lost at 2 ppm to 3 ppm.	White Sturgeon tolerance to low oxygen levels (loss of equilibrium at 1 to 3 mg/l)	Oxygen levels are near saturation under current conditions. These levels are expected to remain high during the NAA. No effect to white sturgeon.	No difference from NAA.	No difference from NAA.	Sediment loads may reach 25,000 mg/l for short periods of time and oxygen may be reduced to near 2 ppm. An estimated 26 days of sediment over 5,000 mg/l could result. Reduced oxygen may be associated with that level of sediment. Short term effects to white sturgeon could result in the loss of sturgeon populations. The loss of mature adult fish would be a significant effect. Long term impacts would include elevated sediment during the spring freshet the following year(s). These conditions may also negatively impact white sturgeon (See WQ Appendices 7-7 thru 7-10).	No difference from NAA.	Sediment loads may reach 25,000 mg/l for short periods of time and oxygen may be reduced to near 0 ppm. An estimated 26 days of sediment over 5,000 mg/l could result. Reduced Oxygen may be associated with that level of sediment.
Adult forage – crayfish, shad, sockeye salmon	Loss of or enhancement of food resources	Currently there is suitable forage for white sturgeon in the lower Snake River. Forage is not limiting. No effect to white sturgeon.	No difference from NAA.	No difference from NAA.	Short Term: Potential loss of adult forage base during breaching. Forage populations could see major reductions during breaching under MO3. This loss would be a major negative impact for white sturgeon adults. Long Term: forage populations would shift and return in 2 to 7 years.	–	–
Redband Rainbow Trout							
See notes - use steelhead comparisons	–	Within the Snake River Basin, redband rainbow trout that interact with the projects are classified as steelhead. Those in tributaries are not likely to be affected by actions at the projects.	–	–	–	–	Redband Rainbow Trout are divided into two subgroups. Those that are anadromous - or steelhead, and interior redband - or resident rainbow trout (Muhlfeld et al., 2015).
Westslope Cutthroat							
See notes on distribution	–	–	–	–	–	–	Westslope Cutthroat occur in Dworshak Reservoir and the Clearwater River Basin, but will not likely be affected by alternatives for this EIS.

Affected Environment Important Relationships/Criteria	Affected Environment Metric	Environmental Consequences NAA	Environmental Consequences MO1	Environmental Consequences MO2	Environmental Consequences MO3	Environmental Consequences MO4	Notes
Kokanee							
Dworshak Entrainment – Average discharge January through March is negatively related to kokanee survival as fish are entrained at higher discharges (Bennett, 1997).	Mean Dworshak outflow (Jan - Mar)	Mean Discharge (Jan-Mar) = 4041 cfs. Highest risk in Late February and all of March. Max = 10,563 cfs. High water years have greater risk of entrainment. Median years have risk in late March.	Mean Discharge (Jan-Mar) = 4016 cfs. Highest risk in March. Max = 10,564 cfs. No change from NAA	Mean Discharge (Jan-Mar) = 7176 cfs. Highest risk in January. Max = 10,000 cfs. Moderate increase in risk in January and early February	Mean Discharge (Jan-Mar) = 4046 cfs. Highest risk in March. Max = 10,568 cfs. No change from NAA	Mean Discharge (Jan-Mar) = 4018 cfs. Highest risk in February and March. Max = 10,582 cfs. No change from NAA	Note: data is not clear on number of fish entrained. Presumed a significant number. Kokanee entrainment is positively related to discharge during January thru March. However, the use of lower gates to release water away from kokanee populations has likely reduced the effect. During winter kokanee congregate near the dam making them susceptible to high discharge. In 1996, high late winter releases caused entrainment losses of ~ 90% of all kokanee (Maiolie and Elam, 1996).
Dworshak Spawning Access – 25% of spawning tributaries are inaccessible if reservoir elevation drops below 1450 in September and October.	Reservoir Elevation	Mean elevation for months of September and October is 1521 ~ 90% access to spawning on a median year. Under current conditions, spawning kokanee will have access to approximately 90% of their spawning habitat.	Mean elevation is 1525 ~ slightly better access than under the NAA ~ 90%. Under MO1 kokanee, would have access to slightly more spawning habitat.	Mean elevation is 1521 ~ Same as NAA ~ 90%.	Mean elevation is 1522 ~ Same as NAA ~ 90%.	Mean elevation is 1521 ~ Same as NAA ~ 90%.	Discussions with project biologists indicate reproduction for kokanee is not an issue.
Northern Pikeminnow							
Prefers slow water in lakes and rivers.	Qualitative discussion of water velocity	Lower Snake River dams have reduced water velocities within this reach. Current velocities are ~ 0.4 feet/second. Reservoir conditions would continue to favor pikeminnow populations.	No difference from NAA	No difference from NAA	Velocities are projected to increase dramatically. Mean velocities under NAA would be ~ 0.4 feet/second while velocities in a breached river would be ~ 4 feet/second. There would be reduced slow water habitat for northern pikeminnow. Higher velocities will likely reduce access or time of exposure to downstream migrating smolts. However, northern pikeminnow are a riverine species, expected to do well in a riverine environment and may increase in numbers per unit area (Corps, 2002).	No difference from NAA	Native fish species with artificially elevated populations due to reservoir environments that favor them. Reward program has probably stabilized these populations.

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Spawn in rivers and lakes when water temperatures reach between 14°C and 20°C, which is usually April to June. These fish spawn over cobble gravel substrates primarily in tailraces on the lower Snake River.	Portion of the habitat dominated by cobble and gravel substrates.	Tailraces and tributary habitats have gravel cobble substrates, while reservoirs have sand. Under the no action alternative the lower Snake River would continue to provide adequate gravel (river/tailrace) and sand (reservoirs) substrates for spawning.	No difference from NAA	No difference from NAA	Lower Snake River Juvenile Migration Feasibility Report (2002) estimates that spawning substrate for Chinook salmon (gravel and cobble similar to NPM needs) would increase from 226 to 3,521 acres under a breach scenario. This alternative would increase spawning habitat for northern pikeminnow in the Snake River.	No difference from NAA	Northern pikeminnow migrate to spawning areas in mid to late spring. These are primarily tailrace areas with clean substrates. Females can release up to 30,000 eggs (Gadomski et al., 2001).
Spawn above 14°C.	Temperatures in reservoir tailrace - Use IHR because of large numbers of northern pikeminnow.	Water temps reach 14°C ~ 5-June. Current temps support successful spawning in late spring.	Spawning Temps reach 14°C ~ 3 Jun - No difference from NAA	Spawning Temps reach 14°C ~ 3 Jun - No difference from NAA	Spawning Temps reach 14°C ~ 31 May – Northern pikeminnow spawning may be induced earlier under MO3.	Spawning Temps reach 14°C ~ 3 Jun - No difference from NAA	Gadomski etal. 2001.
Larvae and juveniles rear along shorelines where shallow water provides forage, low velocities at temperatures > 15°C.	Shoreline habitat available Number of days with surface temperatures > 15C at Ice Harbor June thru October	Rearing habitat in backwaters and slower shoreline habitats. Rearing temperatures (>15°C) from June through October ~ 88.7% of days (10,826). Current habitats and temperatures support successful rearing of northern pikeminnow.	Rearing temperatures over 15°C Jun-Oct 88.3% of days (10777). Slightly fewer days over 15°C. Hotter August and cooler July and September, but no real difference in rearing.	Rearing temperatures over 15°C Jun-Oct 86.9% of days (10616). This would be slightly fewer days over 15°C under MO2. Negligible difference from the NAA	Rearing temperatures over 15°C Jun-Oct 77.6% of days (9479). This would be fewer days over 15°C. Growth of northern pikeminnow juveniles would see minor reductions under MO3	Rearing temperatures over 15°C Jun-Oct 89.3% of days (10897). Slightly more days over 15°C. No real difference in rearing.	Gadomski etal. 2001.
TDG relationship for rearing habitat – shallow water habitats more impacted than deeper habitats.	Days Surface TDG over 120% at IHR April - July	TDG Apr through Jul number of days over 120%. High = 136% TDG; 809/9760 days over 120 = 8.3%; WQ plots show that the majority of these dates are in Jun and July. Under the NAA elevated TDG would have an adverse effect on larval and juvenile northern pikeminnow, primarily in June and July.	High = 136% TDG; 889/9760 days over 120 = 9.1%; WQ plots show that the majority of these dates are in Jun and July. There would be a negligible increase in exposure to high TDG and adverse effect under MO1 vs NAA.	High = 136% TDG; 660/9760 days over 120 = 6.8%; water quality plots show that the majority of these dates are in Jun and July and that there would be a minor decrease in exposure to high TDG in the fall and April through July under MO2 vs the NAA.	High = 104% TDG; 0/9760 days over 120 = 0%; TDG conditions would be ideal for most of the Lower Snake River under this alternative. No negative effects from TDG to northern pikeminnow are expected under MO3.	High = 136% TDG; 5163/9760 days over 120 = 52.9%; WQ plots show major increases in exposure to high TDG from Apr through July and moderate increase in risk in April and May when compared with the NAA. There would likely be negative impacts to northern pikeminnow under MO4.	ODFW sampled northern pikeminnow and did not show increased gas bubble disease. Dramatic gas bubble disease signs were observed with prolonged exposure to 115% in the shallow water. At 125% and 130% TDG in depths of 26 cm mortalities occurred without extensive gas bubble disease signs. With exposure to 125% TDG the times to 50% mortality were northern pikeminnow 15.2 hour.

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Food source – larval and juvenile northern pikeminnow feed primarily on invertebrates.	Status and/or trends in current Invertebrate populations.	Water quality data shows that the lower snake river is mildly Eutrophic with relatively healthy zooplankton populations. Invertebrate populations are limited to reservoir species. Current invertebrate communities support larval and juvenile northern pikeminnow populations.	Warmer August could lead to species shift in zooplankton, but could also have more growth in summer. This could lead to minor increase in food resources for larval and juvenile northern pikeminnow.	No difference from NAA	Change from reservoir to riverine habitats will alter forage base and change productivity. Conversion from zooplankton dominated reservoir to insect dominated stream. Zooplankton expected to drop to less than 10% of current biomass. Would be replaced, in time with macro-invertebrates. Expect a major reduction in food resources during breach with slow return over time. Short term reductions in northern pikeminnow populations followed by slow recovery to some unknown population level.	No difference from NAA	Currently, highest concentrations of zooplankton occur in reservoir reaches with much lower concentrations of zooplankton in river reaches.
Pikeminnow reward program objective to remove 10% to 20% of large northern pikeminnow. Numbers are down from historic highs.	Pikeminnow Population estimates.	Exploitation rates vary from 7.5 to 17%. Under the no action alternative the NPM reward program would continue to remove ~ 12% of the population over 200mm in length.	No difference from NAA	No difference from NAA	No difference from NAA	No difference from NAA	Pikeminnow control program has reduced numbers in recent years. Metric dose not determine differences between the alternatives.
Sediment tolerance – during dam breach, high sediment releases are expected that could exceed northern pikeminnow tolerances.	Northern pikeminnow tolerance to high sediment loads	Mean Sediment concentrations prior to removal ~ 2 mg/l. There would be no negative impacts to NPM under current conditions.	No difference from NAA.	No difference from NAA.	Sediment loads may reach 25,000 mg/l for short periods of time. Over 5,000 mg/l for 26 days. These levels create a severity index of 11 ~ 20-40% mortality of NPM (Newcombe and Jensen 1996).	No difference from NAA.	Measured in time and concentration. Use severity index from Newcombe and Jensen (1996).

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Oxygen tolerance – during dam breach, high sediment releases may increase BOD to levels that deplete oxygen in the system. Equilibrium of northern pikeminnow estimated lost at 2 ppm to 3 ppm.	Northern pikeminnow tolerance to low oxygen levels (loss of equilibrium at 2 to 4 mg/l)	Oxygen levels are expected to remain near saturation during the NAA. No effect to northern pikeminnow.	No difference from NAA.	No difference from NAA.	Sediment loads may reach 25,000 mg/l for short periods of time and oxygen may be reduced to near 2 ppm. An estimated 26 days of sediment over 5,000 mg/l could result. Reduced Oxygen may be associated with that level of sediment. Short term effects to northern pikeminnow could result in the loss of these populations. Long term impacts would include elevated sediment during the spring freshet the following year(s). These conditions may also negatively impact northern pikeminnow.	No difference from NAA.	–
Walleye							
Walleye populations favored by reservoir environments.	Number of walleye in juvenile bypass system or sampling and qualitative discussion of habitat changes	Juvenile bypass system numbers in LMN (2012-2018; 8, 9, 92, 337, 608, 733, 352). Reservoirs in the lower Snake River dams are ideal walleye habitat. Fish are in LMN and IHR, now increasingly in Little Goose and adults are in Lower Granite. Under the No Action alternative walleye numbers are expected to continue to expand upriver and increases in numbers.	No difference from NAA	No difference from NAA	Under MO3, reservoir habitats would be converted to riverine habitats. Walleye numbers would likely decrease and then stabilize at reduced levels	No difference from NAA	Separator numbers increasing as the fish go up the river. Correlate to salmon predation losses. Arntzen et al. 2012
Spawn in spring, 4°C to 10°C over benthic habitats less than 10 feet deep. Gravel or cobble substrates are best. Prefer slow-moving rivers or lakes with wave action to clean substrate.	Quality and quantity of shoreline habitat available.	Suitable water temps for spawning occur from mid Feb to mid Apr. Areas of shoreline gravel and flow exist throughout the Lower Snake River. Under the No Action Alternative adequate spawning habitats exist for walleye.	No difference from NAA	No difference from NAA	Under MO3, reservoir habitats would be converted to riverine habitats. Cobble and gravel substrates are expected to increase significantly under this alternative. At the same time slow water habitats preferred by walleye are expected to decrease significantly. Overall, suitable walleye spawning habitat is likely to increase under MO3.	No difference from NAA	–

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Walleye fry require adequate zooplankton to grow.	Productivity and Zooplankton	Water quality analysis indicates that the lower Snake River is Mesotrophic to lower Eutrophic. Zooplankton and other sources of food for walleye fry are plentiful except in the Clearwater River. Under the no action alternative river and reservoir productivity is relatively high and food resources for walleye fry are plentiful.	Warmer August ~ Possible zooplankton species shift in zooplankton that may lead to increased food resources for pelagic walleye fry.	No difference from NAA	Change from reservoir to riverine habitats will alter forage base and change productivity. Conversion from zooplankton-dominated reservoir to insect-dominated stream. Zooplankton expected to drop to less than 10% of current biomass. Would be replaced in time with macro-invertebrates. Expect reduction in productivity during breach, with slow return over time leading to reductions in walleye populations with likely recovery to some lower population level.	No difference from NAA	Water Quality Appendices 7-7 through 7-10
Rearing – increases in prawns and opossum shrimp (neomysis) food source allows predatory fish to get to piscivory stage sooner (Tiffan et al., 2017a).	Trend in prawn numbers as documented in bypass reports.	Bypass reports: 464,000 individuals collected at LGO in 2015 Introduced shrimp are expected to continue to expand and provide a food source.	Warmer August could increase summer growth and production of zooplankton. May lead to increased food resources for Siberian prawn and Mysid Shrimp.	No change from NAA	Change from reservoir to riverine habitats will dramatically reduce Siberian prawns in the lower Snake River. Zooplankton, the main forage item for Siberian prawns, is expected to drop by over 90%. Mysid shrimp are a lentic species and would be flushed from the system in a riverine system. Losses of these species would likely be replaced by other species, but would lead to short term reductions in walleye populations.	No change from NAA	Mysis shrimp are large portion of the diet for Siberian prawns. Both are food resources for juvenile walleye and smallmouth bass, but the team does not know to what extent.
Juveniles can be limited by high or variable water velocities in rearing areas that transport juveniles to unsuitable habitats.	Water flows or velocities (April - May) at LGR	Median flows in the lower Snake River are relatively high at this time (81,287 cfs) Flows on the lower Snake River are relatively high during fry rearing. Successful rearing will occur at limited sites with adequate shelter from high flows.	Flows in MO1 are not expected to differ from the NAA. Median flow is 81,303. No difference for juvenile walleye.	Flows in MO2 are not expected to differ from the NAA. Median flow is 81,226. No difference for juvenile walleye.	While flows in the lower Snake River for MO3 are not expected to change significantly (81,266), under a breach scenario the team would expect velocities to change dramatically. Estimates of water travel time go from 0.4 feet to 4 feet per second. We expect juvenile walleye rearing habitat to be limited and recruitment of walleyes to be reduced.	Flows in MO4 are not expected to differ greatly from the NAA. Median flow is 81,266. Slightly lower than NAA - no difference for juvenile walleye.	The literature discusses the potential for fry losses due to high or variable flows in rearing areas, but no specific values are given.

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Adults prefer offshore habitat in deeper water during daylight hours and move to shallower feeding sites at night.	Qualitative description of deep water habitat available.	Adult resting and feeding habitats are not limited. Under current conditions there is adequate resting and feeding habitat for adult walleye.	No change from NAA	No change from NAA	Under MO3 there will be reduced resting and feeding habitat. Velocities will be increased dramatically and deep water habitats will be limited. MO3 would reduce suitable habitat for walleye.	No change from NAA	Washington has no limits on bass, walleye, catfish in Columbia River tributaries.
Rearing fry require temperatures > 15°C for growth and feeding.	Temperature from April -July at LGO % of days over 15°C.	Median date that Lower Snake hits 15°C is June 4. Percent of all days over 15°C = 39.3%. Currently, temperatures are cold for optimum growth when fry first hatch. Best growth occurs after mid-June.	Median date that Lower Snake hits 15°C is June 3. Percent of all days over 15°C = 39.2%. No change from NAA	Median date that Lower Snake hits 15°C is June 2. Percent of all days over 15°C = 39.5%. No change from NAA	Median date that Lower Snake hits 15°C is June 10. Percent of all days over 15°C = 42.0%. Negligible increase in warm days for rearing, but there may be a shift later in the year of about a week for rearing to begin.	Median date that Lower Snake hits 15°C is June 3. Percent of all days over 15°C = 39.5%. No change from NAA	–
Sediment tolerance – during dam breach, high sediment releases are expected that could exceed walleye tolerances.	Walleye tolerance to high sediment loads	Mean sediment concentrations prior to removal ~ 2 mg/l. There would be no negative impacts to walleye under current conditions.	No difference from NAA.	No difference from NAA.	Sediment loads may reach 25,000 mg/l for short periods of time. Over 5,000 mg/l for 26 days. These levels create a severity index of 12 ~ 40% to 60% mortality of walleye. Walleye appear to be more resistant to high total suspended solids at first and then more sensitive to long-term total suspended solids. Greater numbers would be expected to die during breaching.	No difference from NAA.	Measured in time and concentration. Use severity index from Newcombe and Jensen (1996).
Oxygen tolerance – during dam breach, high sediment releases may increase BOD to levels that deplete oxygen in the system. Equilibrium lost at 2 to 3 ppm.	Walleye tolerance to low oxygen levels (loss of equilibrium at 2 to 4 mg/l)	Oxygen levels are expected to remain high during the NAA. There would be no negative impacts to walleye under current conditions	No difference from NAA.	No difference from NAA.	Sediment loads may reach 25,000 mg/l for short periods of time and oxygen may be reduced to near 2 ppm. An estimated 26 days of sediment over 5,000 mg/l could result. Reduced oxygen may be associated with that level of sediment. Short term effects to walleye could result in the loss of these populations. Long term impacts would include elevated sediment during the spring freshet the following year(s). These conditions may also negatively impact walleye.	No difference from NAA.	–

Affected Environment Important Relationships/Criteria	Affected Environment Metric	Environmental Consequences NAA	Environmental Consequences MO1	Environmental Consequences MO2	Environmental Consequences MO3	Environmental Consequences MO4	Notes
Smallmouth Bass							
Spawning in slower water of lakes or rivers less than 18 to 20 feet deep. Prefer rocky or cobble habitats. Riprap is good.	Spawning habitat	Spawning habitat abundant in Snake River reservoirs Spawning habitat for smallmouth bass is not limiting on the Lower Snake River	No difference from NAA	No change in NAA	Under MO3, there would be a dramatic change in habitat from reservoir to riverine. Suitable spawning substrate would increase. However, velocities would increase and reduce spawning sites to the slower more protected sites. Spawning habitat is not expected to be a limited habitat under MO3.	No difference from NAA	Warmer temps are conducive to smallmouth bass, rivers and lakes both are good habitat (compared to walleye-lakes preferred)
Optimal range for adult rearing is 21°C to 27°C (Edwards et al., 1983).	Percent of days Temperatures over 21°C at LGO pool - Surface	14.3% of all days over 21°C ~ 52 days a year. Current conditions provide ideal rearing conditions for SMB in the Lower Snake River for only 52 days a year. Temperatures are moderately below optimal growth.	16.6% of all days over 21°C ~ 60 days a year. Under MO1, there would be a negligible increase in days of higher temperatures and ideal rearing conditions for SMB compared to the NAA.	15.1% of all days over 21°C ~ 55 days a year. No change from NAA	1.0% of all days over 21°C ~ 4 days a year. Under MO3, ideal rearing temperatures would be reduced significantly. Surface temperatures that are much warmer in reservoir habitats would be mixed in a riverine system. Smallmouth bass growth would be moderately reduced under this alternative.	14.4% of all days over 21°C ~ 53 days a year. No change from NAA	Edwards et al. (1983) gave the upper temperature limit for adult smallmouth bass as 32°C, the optimum range for adult rearing as 21°C to 27°C, and the optimum range for spawning as 12.8°C to 21°C.
Turbidity can limit smallmouth bass growth and feeding success.	Turbidity levels	Turbidity rarely exceeds 200 NTUs in the lower Snake River. Sontag Thesis (Sontag, 2013) found drop in smallmouth bass predation during high turbidity flows on the Snake River.	Turbidity limits feeding success of smallmouth bass in early runoff of some years (2017) on the Snake River.	No change from NAA	No change from NAA	Total suspended solids expected to reach 20,000 mg/L during breach and remain greater than 5,000 mg/L for 26 days. Elevated concentrations would occur during spring runoff and other high-flow or precipitation events. Will return to less than 50 mg/L after river bed stabilizes (Water Quality Appendix 7-11). Negative short-term impacts with no long term impacts.	No change from NAA

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Dworshak drawdown timing could interrupt spawning/ rearing cycle.	Timing of pool elevation changes/relative to smallmouth bass spawning in Dworshak	Pool at 1520 in winter then fills to 1600 starting in late April or Early May. Reaches full pool by July 4th, then drawdown drops water to 1520 by September. Temps reach 16°C on about May 7th. In most years smallmouth bass will nest and the fry will leave the area before drawdown would desiccate the nest. Under the NAA, smallmouth bass spawning and nesting would not be impaired by drawdowns.	No change from NAA	Overall water levels are lower under MO2 for all water year types, but water levels do not drop until early to mid-July - not likely to desiccate the nests. No change from NAA	No change from NAA	No change from NAA	Smallmouth bass spawn on rocky shorelines at in water depths from 1 to 5 meters. Spawning begins at 16C° ~ early May. Lake levels drop starting in mid-July and likely do not desiccate smallmouth bass nests till late July after smallmouth bass have already reared and moved out (Edwards et al., 1983). Cold water influx after the start of spawning could induce nest abandonment with a possibility for a second less successful attempt when water temperatures warm.
Reservoirs support sand roller (Percopsis transmontana) populations that provide an alternate food source for smallmouth bass when smolts are low or not in the area.	Sand roller population status and change	Sontag (2013) found that ~35%, by weight of SMB diet was sand roller in lower granite pool. Smolts were only 5%. However, Erhardt et al. (2018) found that smolts were a major portion of smallmouth bass diet. Water conditions were different for these years with clear water in 2018 and turbid water in 2013. Under NAA, smallmouth bass will switch to alternate prey if smolts are limited.	No change from NAA	No change from NAA	Under MO3, the four lower Snake River dams would be breached. During breaching, large amounts of sediment would be released and alternate prey populations are expected to be significantly reduced. Under MO3, there would be reduced forage for smallmouth bass for an unknown time period. Smallmouth bass populations would be temporarily reduced.	No change from NAA	Sontag (2013) found that ~35%, by weight of the smallmouth bass diet was sand roller. Smolts were only 5%. Peamouth and chiselmouth were second at ~19% each. Smallmouth bass are piscivorous after about 2 years. Erhardt et al. (2018) estimated that smallmouth bass ate over 300,000 smolts in a 22-km reach of the lower Snake River. Water conditions were different in these years where turbid conditions during the 2013 study limited smallmouth bass foraging success. In 2018, clear water allowed greater success.
Adults go inactive at temperatures less than 10°C.	Water Temps less than 10°C at LGO pool dates above and below and % of days inactive.	Days below 10°C = 46.0% ~ 168 days. Water temps reach 10C at ~ April 25 and back to 10°C on Nov 12. Under the NAA SMB are not likely to be active until May, at which point SMB growth would increase and maximize in July and August. These fish would go dormant in early November.	Days below 10°C = 46.0% ~ 168 days. Water temps reach 10°C at ~ April 25 and back to 10°C on Nov 12. No change from NAA.	Days below 10°C = 46.2% ~ 168 days. Water temps reach 10°C at ~ April 26 and back to 10°C on Nov 12. No change from NAA	Days below 10°C = 49.4% ~ 180 days. Water temps reach 10°C at ~ April 26 and back to 10°C on Oct 26. Under MO3 there would be a minor increase in the length of the winter starvation period for smallmouth bass. Survival would likely decrease slightly and growth would be reduced.	Days below 10°C = 46.0% ~ 168 days. Water temps reach 10°C at ~ April 25 and back to 10°C on Nov 12. No change from NAA	Edwards et al., 1983.

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Affected Environment Important Relationships/Criteria	Affected Environment Metric	Environmental Consequences NAA	Environmental Consequences MO1	Environmental Consequences MO2	Environmental Consequences MO3	Environmental Consequences MO4	Notes
Embryo require temperatures between 13°C and 25°C for normal development. Nest building and spawning occur at 13°C and 20°C.	Water temps after spawning - May thru June.	Water temps reach 13°C at ~ May 8. Days over 13C May thru June = 70.6%. Under the NAA Temperatures are conducive to embryo development ~ 70% of May through June.	Water temps reach 13°C at ~ May 7. Days over 13°C = 75% Under MO1, there would be a minor increase in days of suitable rearing for embryos.	Water temps reach 13°C at ~ May 9. Days over 13°C = 71.8% No change from NAA.	Water temps reach 13°C at ~ May 29. Days over 13°C = 51.5% Under MO3, there would be a moderate reduction in the number of days in May and June that would provide suitable development for smallmouth bass embryos. Survival of smallmouth bass embryos will likely decrease.	Water temps reach 13°C at ~ May 9. Days over 13°C = 74.4% Under MO4, there would be a minor increase in days of suitable rearing for embryos.	There may be another spawning period if there is a sudden drop in temperature during the first attempt. Edwards et al., 1983.
Fry require low flows – velocities of <0.2 meters/ second (0.65 feet/second) for rearing.	Water flow from May 30 to mid-October	At the end of May flows are near their annual peak (113 kcfs). These drop to ~ 70 kcfs by the end of June. Conditions are best for fry in July and August with low flows and high water temps. Under the NAA, rearing habitats would be restricted to backwater and off channel habitats during May and June. These habitats would expand in July and August.	No difference from NAA	No change from NAA.	Under MO3, water flows would not change significantly, but water velocities would increase dramatically. Expect Mean velocity go from ~ 0.4 feet/second to 4 feet/second. Rearing habitat for SMB fry, during May and June, would see major reductions under this alternative relative to the NAA.	No difference from NAA.	–
Sediment tolerance – during dam breach, high sediment releases are expected that could exceed smallmouth tolerances.	SMB tolerance to high sediment loads	Turbidity rarely exceeds 200 NTUs. Total suspended solids are generally around 2 mg/l. Current sediment and turbidity levels are suitable for smallmouth bass growth and survival. High water years with greater turbidity may limit smallmouth bass foraging success.	No difference from NAA.	No difference from NAA.	Sediment loads may reach 25,000 mg/l for short periods of time. Over 5,000 mg/l for 26 days. These levels create a severity index of 11 ~ 20% to 40% mortality of SMB (Newcombe and Jensen, 1996). Under MO3 there would be a Major short term impact from sediment during breaching. Short-term impacts would include greater turbidity during Spring flows ~ 30 mg/l total suspended solids (water quality presentation).	No difference from NAA.	Measured in time and concentration. Use severity index from Newcombe and Jensen, 1996).

Affected Environment Important Relationships/Criteria	Affected Environment Metric	Environmental Consequences NAA	Environmental Consequences MO1	Environmental Consequences MO2	Environmental Consequences MO3	Environmental Consequences MO4	Notes
Oxygen tolerance – during dam breach, high sediment releases may increase BOD to levels that deplete oxygen in the system. Equilibrium lost at 2 ppm to 3 ppm.	Smallmouth bass tolerance to low oxygen levels (loss of equilibrium at 2 to 4 mg/l)	Oxygen levels are expected to remain near saturation during the NAA. No effect to smallmouth bass under the NAA.	No difference from NAA.	No difference from NAA.	Sediment loads may reach 25,000 mg/l for short periods of time and oxygen may be reduced to near 2 ppm. An estimated 26 days of sediment over 5,000 mg/l could result. Reduced oxygen may be associated with that level of sediment. Short term effects to Smallmouth bass could result in the loss of these populations. Long-term impacts would include elevated sediment during the spring freshet the following year(s). These conditions may also negatively impact smallmouth bass.	No difference from NAA.	–
Native Fish Community							
Sucker species (bridgelip, largescale) native spp., requirements similar to northern pikeminnow.	See northern pikeminnow relationships. Also see page B4-27 from Appendix B of the 2002 Juvenile Salmon Migration Feasibility Study (Corps, 2002) for fish expected to be found under the alternatives.	Under the NAA, fish communities would be dominated by reservoir species (walleye, catfish, perch, smallmouth bass, northern pikeminnow, carp, crappie, and sucker)	No Change from NAA	No Change from NAA	Change to riverine species (sucker, northern pikeminnow, smallmouth bass, white sturgeon, mountain whitefish, and sculpin spp.)	No Change from NAA	How do these fish pass through adult ladders? Ladders favor the larger size classes. Assume similar response as northern pikeminnow from alternatives. Under MO3, will these be impacted differently than other species already analyzed?
Mountain whitefish in tributaries do occur in juvenile bypass system samples	Number of fish in bypass	LMN 2017 = 521; 2018 = 235. Varies by year. Effects similar to northern pikeminnow.	No Change from NAA	No Change from NAA	Increase in mountain whitefish relative to NAA.	No Change from NAA	Are mountain whitefish a major species of concern in the lower Snake River?
Game Fish							
Walleye, smallmouth bass, and catfish	See walleye/smallmouth bass	Assume outputs would be similar to those from the walleye and smallmouth bass analysis	NA	NA	NA	NA	Assume metrics that improve smallmouth bass and walleye will help most of the game fish in this basin.
Bluegill, perch, and crappie are reservoir species. Do they need additional analysis?	See walleye for similar results	Reservoir community supported by current conditions.	NA	NA	Would expect large reductions in these fish.	NA	River environment not conducive to these species.

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3.8.5 Region D

3.8.5.1 McNary Dam to Estuary

Table 3-81. Qualitative Effects to White sturgeon and other resident fish in the lower Columbia River - (McNary to Eastuary)

Affected Environment Important Relationships/Criteria	Affected Environment Metric	Environmental Consequences NAA	Environmental Consequences MO1	Environmental Consequences MO2	Environmental Consequences MO3	Environmental Consequences MO4	Notes
White Sturgeon Flow and Temperature Relationship							
Temperature affects suitability for embryo incubation. McCabe and Tracy (1994) captured sturgeon embryos (eggs) in the 11 kilometers of river been river kilometers 223 to 234. In the BON tailrace, white sturgeon spawned at water temperatures ranging from 10°C and 19°C (McCabe and Tracy, 1994). Wang et al. (1985) found successful embryo incubation occurs between 10°C and 18°C, and the optimal water temperatures is from 12°C to 14°C. Wang et al. (1985) also found temperatures above 18°C increase embryo mortality and 20°C and higher is lethal for embryos.	BON temperature, ext. year set. Dates and number of days temperature is >10°C but 18°C, Apr 15 to Jul 15. Optimal same data set >12, <14.	Data Outputs: Days > 10°C, <18°C: 2011 HF/LT: 5/5-7/15, 72 days 2012 AF/LT: 4/23-7/8, 74 days 2013 LF/AT: 4/24-6/28, 66 days 2014 AF/AT: 4/29-6/30, 63 days 2015 LF/HT: 4/18-6/4, 48 days Days >12°C, <14°C: 2011 HF/LT: 5/14-6/9, 27 days (includes 2 days slightly >14) 2012 AF/LT: 5/14-5/30, 17 days 2013 LF/AT: 4/24-6/28, 8 days 2014 AF/AT: 4/29-6/30, 10 days 2015 LF/HT: 4/18-6/4, 15 days (includes 2 days slightly >14)	Data Outputs: Days > 10°C, <18°C – Difference from NAA: 2011 HF/LT: 5/5-7/15, 72 days, 0 2012 AF/LT: 4/23-7/8, 74 days, 0 2013 LF/AT: 4/24-6/28, 67 days, +1 day 2014 AF/AT: 4/29-6/30, 63 days, 0 2015 LF/HT: 4/18-6/4, 48 days, includes 3 days slightly >18°C). Similar to NAA. Days >12°C, <14°C – Difference from NAA: 2011 HF/LT: 5/14-6/9, 27 days, 0 (includes 2 days slightly >14) 2012 AF/LT: 5/14-5/30, 17 days	Data Outputs: 2011: 5/5-7/15; 72 days 2012: 4/23-7/8; 74 days 2013: 4/24-6/27; 67 days, plus 1 day 2014: 4/29-6/30, 63 days 2015: 4/18-6/5; 49 days, similar to NAA. Effects to Resource: Same as NAA. Notes:	Data Outputs: Days >10, <18: 2011 HF/LT: 5/5-7/15, 72 days 2012 AF/LT: 4/22-7/7, 74 days 2013 LF/AT: 4/24-6/28, 66 days 2014 AF/AT: 4/29-6/30, 63 days 2015 LF/HT: 4/18-6/4, 48 days Days >12, <14: 2011 HF/LT: 5/14-6/9, 27 days (includes 2 days slightly >14) 2012 AF/LT: 5/18-6/11, 17 days, more fluctuations 2013 LF/AT: 5/4-5/9, 6 days, -2 days 2014 AF/AT: 5/10-5/21, 12 days, +2 days 2015 LF/HT: 5/1-5/15, 15 days (includes 2 days slightly	Data Outputs: Days >10, <18: Difference from NAA 2011 HF/LT: 5/5-7/15, 72 days, 0 2012 AF/LT: 4/23-7/8, 74 days, 0 2013 LF/AT: 4/23-6/28, 67 days, +1 day 2014 AF/AT: 4/29-6/29, 62 days, -1 day 2015 LF/HT: 4/186/4, 42 days, Includes 3 days slightly > 18°C), Similar to NAA. Days >12, <14: Difference from NAA 2011 HF/LT: 5/14-6/9, 27 days, 0	–

Columbia River System Operations Environmental Impact Statement
Appendix E: Fish, Aquatic Macroinvertebrates, and Aquatic Habitat

Affected Environment Important Relationships/Criteria	Affected Environment Metric	Environmental Consequences NAA	Environmental Consequences MO1	Environmental Consequences MO2	Environmental Consequences MO3	Environmental Consequences MO4	Notes
		Effects to Resource: Differences in temperature regime could have an effect on sturgeon spawning. Under the NAA, BON tailrace would provide white sturgeon with the proper temperatures for spawning from mid-Apr to mid-Jul in high water years, and from mid-Apr through Jun in average water years. In years of low flow conditions, water could get too warm for sturgeon recruitment by Jun, resulting in poor or no recruitment. Notes: Could use input from others on whether looking at temperatures in BON tailrace would be useful or if another metric would be better? (Comment from Bjorn van der Leeuw.) For BON tailrace, McCabe and Tracy (1994) mentioned spawning months as mid-Apr to mid-Jul.	2013 LF/AT: 4/24-6/28, 8 days 2014 AF/AT: 4/29-6/30, 10 days 2015 LF/HT: 4/18-6/4, 15 days (includes 2 days slightly >14) Effects to Resource: Same as NAA. Notes: Incubation at 14°C to 16°C is about 5 to 7 days. At upper end, the temperature climbs up within a week, and the eggs are very sensitive to increasing temperatures. Temperature is a bigger driver than flows. Need flows to broadcast/disperse the eggs.		>14°C) Effects to Resource: Same as NAA. Notes: See BON_Mapped80yrTemp_NAA	(includes 1 day slightly >14) 2012 AF/LT: 5/7, 5/8, 5/14-5/30, 19 days, +2 days 2013 LF/AT: 5/4-5/9, 6 days, -2 days 2014 AF/AT: 5/11-5/20, 10 days, 0 2015 LF/HT: 5/1-5/13, 14 days (includes 1 day slightly >14°C), -1D Effects to Resource: Similar to NAA. Notes:	
Spawning – flows needed for successful spawning and recruitment. 250 kcfs in Apr 1-Jul 31 in MCN tailrace. Since lower Columbia dams are run-of-river, outflow at MCN will correlate with outflows at JDA, TDA, and BON.	MCNARY_OUT_FLOW summary hydrograph Days >250 kcfs from 4/1-7/31 and number of those days within temperature requirements (above). Alternate method: 5 Ext Yr from WQ, flows and temperatures.	Data Outputs: Median: 5/16-6/21, 35 days 25th percentile: 4/17-7/14 (88 days, all within temperature requirement) Alternate Method – (See MCN_Ext_Yr_NAA) 2011: 5/12-7/24 (74 days) 2012: 4/25-7/11 (78 days) 2013: 5/9-6/30 (53 days, minus 11 that fall below 250 kcfs in that period) 2014: 4/14-6/14, plus 5 more (49 days, not all consecutive) 2015: 0 days (extreme low water year) Effects to Resource: Flow and temperature conditions would continue to be adequate for sturgeon	Data Outputs: Summary hydrograph days >250 kcfs Median May 17-Jun 20, 34 days 25 percentile: 4/19-7/13, 85 days Alternate Method – See MCN_Ext_Yr_NAA 2011: 5/12-7/24, 74 days 2012: 4/25-7/11, 78 days 2013: 5/9-6/29 (52 days, minus 12 fall below 250 kcfs in that period) 2014: 4/14-6/14, plus 5 more (49 days, not all consecutive) 2015: 0 days (extreme low water year) Change in Average Monthly Outflow: May: -2%	Data Outputs: Effects to Resource: Spawning and recruitment would be similar to the NAA in high and average flow years. In low years (2013), about 8 fewer days in recruitment conditions, but in low water years there is no recruitment and the concern is with survival, which is dependent on temperature. Temperature would be similar to the NAA. Notes:	Data Outputs: Summary Hydrograph days > 250 kcfs Median: 5/17-6/20 (34 days) 25th Percentile: 4/18-7/13 Alternate method – See MCN_ExtYr_NAA_working 2011: 5/12-7/24, 74 days 2012: 4/25-7/11, 78 days (same number, 1 day later) 2013: 5/9-6/28, 51 days (-16 fall below 250 kcfs in that period) 2014: 5/3-6/22, 6/21-6/29 (51 days) 2015: 0 days (extreme low water year) May/June flows Effects to Resource: Wet and average years similar to NAA.	Data Outputs: Summary Hydrograph: Median: 5/17-6/21 (35 days) 25th Percentile: 4/19-7/13 (85 days) Alternative method: See MCN_ExtYr_NAA_working Effects to Resource: Wet and average years similar to NAA. Dry years NAA and MO4 were similar, still high risk for sturgeon survival in LF/HT years. MO4 provided an extra day in optimal range in AF years. Notes: Extreme low years (2015), no spawning under any alternatives, but into survival mode. 18°C to 20°C, duration, and how quickly to those temperatures are critical.	–

Affected Environment Important Relationships/Criteria	Affected Environment Metric	Environmental Consequences NAA	Environmental Consequences MO1	Environmental Consequences MO2	Environmental Consequences MO3	Environmental Consequences MO4	Notes
		spawning and recruitment most of the mid-Apr to mid-Jul time in high flow years, but only about half that time in average flow conditions. Low flow years would likely not provide enough time with suitable conditions for any recruitment to occur. Notes: Optimal temperature and flows in X days would be a good spawning year. Opportunity to look at if temperature correlates to flows in effects analysis modeling with both datasets. This criteria is also important for successful recruitment and larval drift. This amount of flow and above 250 kcfs also maintains more consistent forebay/tailrace elevations, and reduces chance of stranding/dewatering below BON. In years of extreme low flows and warm water, higher than typical adult mortalities have been documented (Olaf Langness document, e.g., 2015).	Jun: -1% Effects to Resource: Median years, 2 fewer days; high flow years, 3 fewer days within temperature and flow window. There could be a slight reduction in years with recruitment success. Notes: Graphic that shows it more clearly over years... Above 17°C leads to mortality. JDA pool is an outlier. 7 of the last 21 years were successful. Successful spawning over time in each of the pools. Overlay temperatures, check with water quality to use this way.		Dry year, more days in June with flows below 250 kcfs would reduce spawning success. Less days with turbulent flow to disperse eggs. Timing in Jun could affect larval dispersal. About 14°C trigger spawning. In LF/HT years, the rate of increased temperatures was faster, would increase risk of mortality. LF/HT concern is with survival. No recruitment, focus on survival of adults. Faster rate of rise up from 18°C to 20°C is higher stress, especially on females. AF/AT year, reached 20°C quicker. In Jul, increased risk of atresia later in spawning period. LF/AT year not much difference, slightly fewer days, but very close in temp. HF/LT year MO3 offers more days in optimal. Also a little slower getting up and past 20°C. Late Jul-Aug, extend better survival days. Notes: See BON_Mapped80yrTemp_NAA for this data. See Flow_Fcst_Comparisons for incremental lower flows in May/Jun in dry years. Any sturgeon recruitment under any alts? See McNary_Outflo Additional days in April may increase cues, but days in Jun are more critical to recruitment from the egg and larval dispersal mechanism. Lower projects more mixed; 2015 die-offs more in JDA, 2015 more in JDA and TDA and MCN, BON less die-offs noticed; more thermal	Stress contributed to atresia, temperature conditions also caused Chinook salmon die-offs, sturgeon gorged = metabolic stress.	

Affected Environment Important Relationships/Criteria	Affected Environment Metric	Environmental Consequences NAA	Environmental Consequences MO1	Environmental Consequences MO2	Environmental Consequences MO3	Environmental Consequences MO4	Notes
					refugia? (Olaf has report of this.)		
Spawning generally occurs in areas with fast-flowing waters over coarse substrates (Parsley et al., 1993). McCabe and Tracy (1994) concluded that spawning in the BON tailrace occurred in days with mean discharges from BON ranging from 120 kcfs to 371 kcfs.	BON outflow: Bonneville_Out_Flow (Excel file). Mean monthly outflow, Apr-Jul. +Qualitatively look at hydrographs of lo, average, and hi years.	Data Outputs: Median outflows: Apr = 212989 May = 275261 Jun = 295709 Jul = 204315 99% outflows: Apr = 120584 May = 189943 Jun = 168665 Jul = 128003 Effects to Resource: From the data provided by H&H, it shows the BON tailrace always has flows 120 kcfs or greater from Apr to Jul for suitable spawning habitat. Note: This does not indicate flows adequate for sturgeon using the habitat or for recruitment. See above flow/temp relationship. Notes:	Data Outputs: Change from NAA Median outflows: Apr: 208,570 (-2%) May: 268,886 (-2%) Jun: 293,731 (-1%) Jul: 202,273 (-1%) 25% Outflows Apr: -2% May: -2% Jun: -1% Jul: -1% Effects to Resource: Outflows during spawning months would be well within the range of spawning needs for white sturgeon below BON, but would be slightly less (1%-2% is median water years and 1%-5% in very dry years) than the NAA. Minor changes in outflows would not relate to discernable changes to velocities. Sturgeon habitat would be similar to NAA. Notes: Use MCN flows >250 kcfs as the criteria for successful spawning at all lower Columbia areas. Counihan and Chapman, 2018. Discharge 6/16-7/31 focused more on recruitment.	Data Outputs: Change from NAA Median outflows: Apr: -2% May: -1% Jun: -1% Jul: same as NAA Effects to Resource: Same as NAA. Notes:	Data Outputs: Change from NAA Median: Apr: -2% May: -3% Jun: -2% Jul: -1% 25th (Higher flows): Apr: -2% May: -2% Jun: -1% Jul: -1% Effects to Resource: Same as MO1 Slightly lower flows in pre-spawning period could reduce sediment transport slightly. Not a big impact from flows. Notes:	Data Outputs: Median outflows: Apr: 208,220 (-2%) May: 270,820 (-3%) Jun: 292,998 (-1%) Jul: 204,946 (+3%) Effects to Resource: Minor changes in outflows would not relate to discernable changes to velocities. Notes:	—
Availability of interstitial habitat important for survival and growth of yolk sac and feeding larvae. Substrate alteration (if present) would have multiple effects on white sturgeon in the lower Columbia River downstream of BON.	Change in peak flows or sediment transport.	Data Outputs: Effects to Resource: Notes: Change in peak flows can affect scouring of habitat. Increased peak flows keep interstitial habitats. Annual distribution of sediment, where eggs and larvae settle need peak flows to clean substrate. Combine with interstitial space. If tied to	Data Outputs: River mechanics, Chapter 3. No change. Effects to Resource: Same as NAA. Notes:	Data Outputs: River mechanics, Chapter 3. No change. Effects to Resource: Notes:	Data Outputs: Dam breach – Sediment team “due to the increase in amount of sediment passing from the Snake River, potential increase in amount of sediment.” Effects to Resource: Slightly lower flows in pre-spawning period could reduce sediment transport slightly. Not a big impact from flows.	Data Outputs: River mechanics, Chapter 3. No change. Effects to Resource: Same as NAA. Notes:	—

Affected Environment Important Relationships/Criteria	Affected Environment Metric	Environmental Consequences NAA	Environmental Consequences MO1	Environmental Consequences MO2	Environmental Consequences MO3	Environmental Consequences MO4	Notes
		sediment changes in MO3? Likely changes mostly attenuated by BON dam. Hydrology regime is more important to manage any sedimentation effects from dam breach scenarios.			Dam breach could increase sediment and fill in interstitial spaces. Notes: Dam breach – sediment.		
Lack of upstream white sturgeon (both juvenile and adult) passage prevents population connectivity (Parsley et al., 2007).	Presence of physical barrier. Qualitative assessment of measures.	Data Outputs: None. Effects to Resource: Continued disconnection. Under the NAA, dams will stay6 in place without any major modifications to existing fish passage structures. BON will continue to provide a negligible amount of passage for sturgeon through the fishways. White sturgeon passage downstream through BON (likely through spillways and turbine unites) has not been measured. Notes: There is a net downstream movement of sturgeon through dams, so very few sturgeon move upstream through BON by the fishways, but PIT data shows sturgeon move downstream through BON, most likely through the spillway. Some connectivity downstream, very little upstream; populations continue to be isolated in NAA; may be some effect of PHSP structures or new turbines/ slow roll starts.	Data Outputs: S4: Modify BON ladder. Effects to Resource: Would depend on fishway spacing. Likely a benefit to sturgeon passage where sturgeon are able to enter ladders. Vertical slot fishway easier for sturgeon to pass upstream. Notes: Fish passage for sturgeon is not a ladder; ladders are not effective for sturgeon. Possible small incremental benefit if sturgeon are able to use the ladder. Need to specifically look at case by case basis. WA and Bradford fishways pass a few sturgeon but very rare. Not likely to use them.	Data Outputs: No mods that would improve sturgeon passage. Effects to Resource: Same as NAA. Notes:	Data Outputs: Modify BON ladder Effects to Resource: Same as MO1, possible slight incremental benefit. Notes: Bradford and WA shore ladders; sturgeon are able to get into these ladders, but sturgeon don’t sue the ladders much. (Comparing to The Dalles – TDA is much bigger ladder and still passes relatively few sturgeon.)	Data Outputs: Same as NAA. Effects to Resource: Same as NAA. Notes:	–
Turbine units at BON are a known source of injury and mortality for juvenile and adult sturgeon. Also relative to JDA, TDA.	Qualitative assessment of measures.	Data Outputs: None. Effects to Resource: Injury to white sturgeon during turbine unit startups can lead to injury and direct mortality. Under the NAA, this would continue to possibly occur, although it has never been measured and the slow	Data Outputs: IFP turbines at JDA. Effects to Resource: Could have a positive effect for sturgeon in the JDA pool, lower impact mortality and injury. Unknown survival through sturgeon. Idaho Power may have data on passage survival through the	Data Outputs: IFP turbines at JDA. Effects to Resource: Same as MO1 Notes:	Data Outputs: IFP turbines at JDA. Effects to Resource: Same as MO1. Notes:	Data Outputs: IFP turbines at JDA. Effects to Resource: Same as MO1. Notes:	McCabe and Tracy, 1994.

Affected Environment Important Relationships/Criteria	Affected Environment Metric	Environmental Consequences NAA	Environmental Consequences MO1	Environmental Consequences MO2	Environmental Consequences MO3	Environmental Consequences MO4	Notes
		roll procedure has presumably greatly reduced blade strikes during turbine startups. Notes: The occurrence of blade strikes has been greater reduced by the slow roll procedure for turbine unit start-ups. Need to make sure the slow-roll is being used at all of BON.	turbines. Effective for smaller fish (steelhead). Notes: They swim into draft tubes from downstream.				
TDG effects on sturgeon larvae – 118% altered buoyancy, 131% had 50% mortality rate in lab (Counihan et al., 1998).	TDG	Data Outputs: Effects to Resource: Notes:	Data Outputs: Spill test 115/120. Effects to Resource: Similar to NAA. Notes:	Data Outputs: Spill to 110%. Effects to Resource: Less effects than NAA. Notes:	Data Outputs: Spill to 120% - See water quality presentation. Effects to Resource: MCN and BON – Reduced TDG levels in Aug could reduce exposure. MO3 is below 110, NAA is above in Aug. JDA and TDA – Higher TDG at JDA mid-Apr through mid-June, could be critical time for emerging larvae seeking refuge in interstitial spaces. Lower than NAA in Aug, below 110. Notes: Scott B. – depth compensation reduces effects of TDG. This relationship developed with lab studies. Sturgeon typically in lower part of water column. Shallow areas important to larvae so could be affected by TDG.	Data Outputs: Spill to 125%. See water quality presentation for MO4 – TDG compared to NAA. Effects to Resource: Increased TDG, prolonged increase of TDG from 120 to about 125% TDG at MCN, JDA, TDA, and BON. Expect detrimental effects to juvenile sturgeon. Eggs and larvae most susceptible. Depth compensation – adults tend to be lower to be able to compensate. Larvae mostly also in deep eddy areas where likely less TDG, but if swept near shore they could be very susceptible. Notes: Depth compensation is 10% per meter in the water.	–
Changes in pool/tailrace elevation affect early juvenile life stage survival (egg, incubation, free-swimming larvae).	Look at summary hydrographs for drops in pool elevation at JDA, TDA, BON.	Data Outputs: Pool elevations are steady. Effects to Resource: N/A Notes: Can have spawning every year, doesn't mean will get recruitment, movement of juveniles down to right habitat is important.	Data Outputs: Approximately 1 foot higher JDA pool elevations late Mar-early June (avian predation measures) Effects to Resource: Drop in early June could strand larvae in JDA pool. Notes:	Data Outputs: No operational changes to elevations. Effects to Resource: Same as NAA. Notes:	Data Outputs: Operate JDA between elevations 262.5 and 265.5 (2.5 feet more range than NAA). See MO3 draft change description. Effects to Resource: Slight increase in SWH with 1-foot elevation increase habitat available for juveniles. If elevation is higher, then drops in June (as modeled in draft change document), then could	Data Outputs: JDA, TDA, BON all drawdown to MOP from late Mar to mid-Aug. Effects to Resource: Not likely to strand, drawdown is prior to spawning times. However, lower elevations would likely lead to less SWH available for larvae habitat. Notes:	–

Affected Environment Important Relationships/Criteria	Affected Environment Metric	Environmental Consequences NAA	Environmental Consequences MO1	Environmental Consequences MO2	Environmental Consequences MO3	Environmental Consequences MO4	Notes
					potentially strand larvae that have moved into the SWH. Notes: Had deleted this relationship in MO1 workshop as redundant with flow. Added back in here for JDA pool measure. Rate of change? – Elevation changes in spring/summer would be similar to what happens throughout the year. Up or down 1 foot to 1.5 feet in a day. How much shoreline inundated with 1-foot elevation change. Check with wildlife team or Chuck. May fluctuate – go down for a couple hours, then back up, or a day (example on weekends). Drop in modeled elevation in Jun may be a modeling artifact – measure is through end of Sep. Sue ask Kasi.		
Load following at BON has been shown to dewater early life stages downstream of BON (van der Leeuw et al., 2006).	BON tailrace elevation – daily changes.	Data Outputs: Effects to Resource: Notes: Fluctuations in tailrace (BON) are larger than pool elevation.	Data Outputs: Same as NAA. Effects to Resource: Notes:	Data Outputs: Ramping rates for safety. Effects to Resource: Same as NAA. Notes: See MO3 notes. Would not expect elevation changes at BON.	Data Outputs: Ramping rate restrictions? No installation of fish screens? Effects to Resource: Same as NAA. See notes. Notes: Birgit – no elevation changes, wouldn't expect changes at BON. BON doesn't have ramping rate restrictions.	Data Outputs: Same as NAA. Effects to Resource: Same as NAA. Notes:	Parsley et al., 2007
Pinnipeds, mainly Stellar sea lions, are known to prey on white sturgeon in the BON tailrace. Stellar sea lions have increased their abundance and seasonal presence (Tidwell et al., 2019).	Qualitative assessment of predation risk.	Data Outputs: None. Effects to Resource: Pinnipeds may have altered the spawning of white sturgeon in BON tailrace as they attempt to avoid predation. The ODFW points out that there is direct predation on sturgeon and harassment of spawning sturgeon by Stellar sea lions. The harassment can cause sturgeon to depart the spawning area or abort	Data Outputs: Effects to Resource: Lower flows at BON in dry years May and Aug could increase predation risk. Notes: Changes in temperature/flow likely not changing pinniped predation. Changes in spill? Likely not. Don't see predation right in the tailrace. Sturgeon have likely moved in response to the predation pressure from sea lions. Still seeing evidence of sea lion predation in the	Data Outputs: Effects to Resource: Notes:	Data Outputs: 99% Exceedance (lowest flow years) May: -5% Jun: -2% Jul: -5% Effects to Resource: Lower flows in May-Jun in low flow years could exacerbate issues with crowding increasing predation risk. Notes: Spill/flows would not change pinniped behavior or numbers,	Data Outputs: Spill to 125% Effects to Resource: Notes:	–

Affected Environment Important Relationships/Criteria	Affected Environment Metric	Environmental Consequences NAA	Environmental Consequences MO1	Environmental Consequences MO2	Environmental Consequences MO3	Environmental Consequences MO4	Notes
		spawning for the year (reabsorption of eggs). Continued predation, degree uncertain. Direct mortality of spawning fish and juvenile fish, also sea lions harassing the white sturgeon (making white sturgeon injured or having to spawn elsewhere). Colin Chapman of ODFW pointed out that harassment of spawning sturgeon may lead to stress and aborting spawning activity for that year. Female sturgeon are able to resorb eggs if they abort spawning. Notes: ODFW (Peter Stevens) is working on a memo that links the increase in Stellar sea lions to an overall reduction in year classes of sturgeon on the lower Columbia River population. The immediate BON tailrace is the only area of the lower Columbia River systematically observed to measure predation of white sturgeon by pinnipeds (primarily Stellar sea lions). Pinniped predation had been increasing, recently reports are less in the BON tailrace (unclear if predation less, sturgeon gone, or sturgeon moved). Future hazing/removal of pinnipeds uncertain below BON; downstream predation degree is uncertain. Pinniped predation on white sturgeon has also been observed in the lower Willamette River. The BON tailrace is in a state of flux in reference to pinnipeds. Sturgeon predation by pinnipeds peaked in 2010 and has been in strong decline since. It seems that white	lower river. CRSO operations not the affecting factor.		but could change fish concentration. (Bjorn) If fish are present, sea lions will predate on them. Anything concentrates sturgeon? Or salmon – predation is intense when salmon are in the area. 2015 – saw aggregations of fish at ladders, with high numbers of pinnipeds. WA shore – low water could concentrate fish. At low flows, operations (using only 2 powerhouses) tends to concentrate fish more. Not enough water to use PH1. Just PH2 producing power and no flow at PH2, and forced spill. Presence of salmonids decreases risk of sturgeon predation. (Based on observations at the dam only). CRITFC surveys further downstream. Differences in pinniped species. Stellar sea lions eat more sturgeon than California sea lions. Any relationship with how spill may affect?		

Affected Environment Important Relationships/Criteria	Affected Environment Metric	Environmental Consequences NAA	Environmental Consequences MO1	Environmental Consequences MO2	Environmental Consequences MO3	Environmental Consequences MO4	Notes
		sturgeon do not use the BON tailrace for overwintering habitat now (conjecture from Bjorn), mainly due to the presence and predation pressure from Stellar sea lions. New Federal law passed in 2018 will allow for the removal of Stellar sea lions in the Columbia River. This may alter the number of Stellar sea lions that inhabit the BON tailrace.					
Sculpin, walleye, and smallmouth bass are predators of embryos and age-0 white sturgeon.	Qualitative.	Data Outputs: Coordinate with resident fish teams. Effects to Resource: Under the NAA, predatory fish will continue to consume white sturgeon early life stages and age-0. Notes: The rate of predation has never been measured.	Data Outputs: Not likely to change walleye, sculpin, and bass populations. Effects to Resource: Same as NAA. Notes:	Data Outputs: Not likely to change walleye, sculpin, and bass populations. Effects to Resource: Same as NAA. Notes:	Data Outputs: Not likely to change walleye, sculpin, and bass populations. Effects to Resource: Same as NAA. Notes:	Data Outputs: Not likely to change walleye, sculpin and bass populations. Effects to Resource: Same as NAA. Notes:	Tidwell et al., 2019
Reservoir maturation trend – changes in prey species availabilities over time (diet and diet competition changes with size).	–	Data Outputs: Effects to Resource: Notes: Reservoir environments may be in maturation, sedimentation, and invasive macrophytes could reduce conditions for sturgeon (predation, food availability, invasive spp., etc.) as reservoirs mature. Any changes that could change prey species availability/food webs. White sturgeon eat – larva - plankton, diatoms juveniles- crayfish, clams, then fish adults - larger fish Growth rates patterns, Snake River growth rates change over time. (Growth rates faster in recent years).	Data Outputs: No changes. Minor changes in water quality team matrix of slightly higher zooplankton production, but not likely an effect. Effects to Resource: Notes: No changes.	Data Outputs: Effects to Resource: Notes:	Data Outputs: Not likely to change walleye, sculpin, and bass populations. Effects to Resource: Notes:	Data Outputs: Effects to Resource: Notes:	Carcass observations, WDFW reports (Olaf summary report).
The area downstream of BON provides good spawning habitat over the range of flows that typically occur (Parsley and	BON Outflow. Number of days mean outflow from BON is greater than 75 kcfs during spawning months. For BON	Data Outputs: Bonneville_Out_Flow (Excel file)	Data Outputs: Effects to Resource: Notes:	Data Outputs: Effects to Resource: Notes:	Data Outputs: Effects to Resource: Notes:	Data Outputs: Effects to Resource: Notes:	–

Affected Environment Important Relationships/Criteria	Affected Environment Metric	Environmental Consequences NAA	Environmental Consequences MO1	Environmental Consequences MO2	Environmental Consequences MO3	Environmental Consequences MO4	Notes
Beckman, 1994). White sturgeon are known to spawn in the tailrace of BON. Parsley and Beckman (1994) determined that high-quality spawning habitat was present at discharges greater than 74,867 cfs (round up to 75 kcfs). The amount of spawning habitat for white sturgeon increased as discharge increased.	tailrace, McCabe and Tracy (1994) mentioned spawning months as mid-Apr to mid-Jul.	Average_Monthly_Discharge tab Median outflows: Apr = 212989 May = 275261 Jun = 295709 Jul = 204315 Modeled 99% outflows: Apr = 120584 May = 189943 Jun = 168665 Jul = 128003 99% chance exceeding 75kcfs every day mid-Apr to mid-Jul. Effects to Resource: From the data provided by H&H, the BON tailrace always has flows 75kcfs or greater from Apr to Jul. Under the NAA, the BON tailrace provides adequate flows to support white sturgeon spawning. Notes:	WDFW, ODFW interpretation, the flows at MCN, 250 kcfs are the correct optimal flows to continue on down below BON. Use MCN 250 kcfs. Recruitment data shows less recruitment at the lower levels. Flows at 120 kcfs may provide spawning habitat, but recruitment needs higher flows. See MCN 250 kcfs. Downstream of BON has more complex habitat and takes less water to be successful, but won't see a difference in this metric.				
Flow affects larval dispersal. McCabe and Tracy (1994) captured white sturgeon larvae from river kilometer 45 to river kilometer 232, suggesting wide dispersal after hatching. Larvae were collected as far downstream as the upper end of the Columbia River estuary, which is a freshwater environment.	BON Outflow	Data Outputs: Median outflows: Apr = 212989 May = 275261 Jun = 295709 Jul = 204315 99% outflows: Apr = 120584 May = 189943 Jun = 168665 Jul = 128003 Effects to Resource: In general, it seems that the lower Columbia River produces a year class every year. Under the NAA, this trend would continue. Notes:	Data Outputs: Median outflows: Apr: 208,570 (-2.0%) May: 268,886 (-2.3%) Jun: 293,731 (-0.9%) Jul: 202,273 (-0.7%) 99% outflows: Apr: 118,394 (-1.8%) May: 180,280 (5.0%) Jun: 166,684 (-1.2%) Jul: 125,666 (-1.8%) Effects to Resource: Notes: Include in flow/temperature relationship for recruitment.	Data Outputs: Effects to Resource: Notes:	Data Outputs: Effects to Resource: Notes:	Data Outputs: Median outflows: Apr: 208,220 (-2.3%) May: 270,820 (-2.9%) Jun: 292,998 (-1.1%) Jul: 204,946 (+3.3%) 99% outflows: Apr: 117,910 (-2.2%) May: 211,380 (+10%) Jun: 167,146 (-0.1%) Jul: 121,251 (-5.2%) Effects to Resource: Notes:	—
White Sturgeon Measures (Suites)							—
Water velocity and substrate for spawning habitat (combined in flow and temperature relationship).	BON Outflow	Data Outputs: Effects to Resource: High water velocity is a benefit to white sturgeon spawning.	Data Outputs: Effects to Resource: Notes:	Data Outputs: Effects to Resource: Notes:	Data Outputs: Effects to Resource: Notes:	Data Outputs: Effects to Resource: Notes:	—

Affected Environment Important Relationships/Criteria	Affected Environment Metric	Environmental Consequences NAA	Environmental Consequences MO1	Environmental Consequences MO2	Environmental Consequences MO3	Environmental Consequences MO4	Notes
		Adhesive eggs are widely distributed by high water velocity and clean course substrates provide a good surface for the adhesive eggs to attach (Parsley et al., 2002). Flows create more turbulent water that is beneficial for spawning habitat (keeps predators away, aerates, embryos, spreads out). Notes: It seems BON tailrace provides consistent spawning habitat each spring.					
Spawning – flows needed for successful spawning. 250 kcfs in Apr 1 to Jul 3 in MCN tailrace. Since lower Columbia River dams are run-of-river, outflow at MCN will correlate with the outflows at JDA, TDA, and BON.	Outflow at MCN tailrace.	Data Outputs: MCNARY_OUT_FLOW Excel file. Summary hydrograph > 250 kcfs Median May 16 to Jun 21 (35 days) 25th Percentile (highest water years): Apr 17 to Jul 14 (88 days) (Specific dates taken from Summary_Discharge_Hydrographs). Effects to Resource: Provides optimal spawning flows throughout spawning season in average years or above, and high enough flows to provide spawning in 75% of the time (this statement needs to be verified). Team – is magnitude or duration more important? Number of days? Or higher flow? (can look at mean monthly) Notes: Optimal temperature and flows in X days would be a good spawning year. Opportunity to look at if temperature is a correlate of flow in effects analysis modeling with both datasets.	Data Outputs: Summary Hydrograph days >250 kcfs Median: 5/17-6/20 (34 days) 25 Percentile: 4/19-7/13 (85 days) Effects to Resource: Notes: Graphic that shows it more clearly over years... Above 17°C leads to mortality. JDA pool is outlier. 7 out of last 21 years were successful. Successful spawning over time in each of the pools. Overlay temperatures, check with water quality to use this way. Blaine – has a figure of sturgeon recruitment graphed on flow and temperature conditions. EP values? Proportion of nets with a positive catch = 1 sturgeon caught. Also have CPUE. Published annually in sturgeon management task force annual updates. Laura email link to these.	Data Outputs: Effects to Resource: Notes:	Data Outputs: Effects to Resource: Notes:	Data Outputs: Summary Hydrograph: Median 5/17-6/21 (35 days) 25th Percentile 4/19-7/13 (85 days) Effects to Resource: Notes:	–

Affected Environment Important Relationships/Criteria	Affected Environment Metric	Environmental Consequences NAA	Environmental Consequences MO1	Environmental Consequences MO2	Environmental Consequences MO3	Environmental Consequences MO4	Notes
		This criteria is also important for successful recruitment and larval drift. This amount of flow and above 250 kcfs also maintains more consistent forebay/ tailrace elevations and reduces chance of stranding/dewatering below BON. In years of extreme low flows and warm water, higher than typical adult mortalities have been documented (Olaf Langness document e.g., 2015).					
Changes in pool/tailrace elevation affect early juvenile life stage survival (egg, incubation, free swimming larvae).	Covered below under flow criteria, do not retain separate.	Data Outputs: Effects to Resource: N/A Notes: Can have spawning every year, doesn't mean will get recruitment; movement of juveniles down to right habitat is important. Possible stranding in shallows.	Data Outputs: Delete this relationship. Effects to Resource: Notes:	Data Outputs: Effects to Resource: Notes:	Data Outputs: Effects to Resource: Notes:	Data Outputs: Effects to Resource: Notes:	–
Appropriate temperature for embryo incubation time Bjorn – combine with first line? Or is that one spawning trigger and this one egg development? Combined with flow and temperature relationships.	Optimal is 14°C to 16°C	Data Outputs: May to Jul temperatures in tailraces below all 8 projects. Effects to Resource: Some years temperatures maintained, others may not be in NAA. Increase in egg morality >18°C. Complete mortality >20°C. No regulations in place currently. Notes: Colin Chapman has a metric for temperature weighted usable area for spawning habitat (Parsley et al.), turbulence and flow not captured. Metric covers spawning and incubation; not covering once moving, stable temperatures als–o important.	Data Outputs: Effects to Resource: Notes:	Data Outputs: Effects to Resource: Notes:	Data Outputs: Effects to Resource: Notes:	Data Outputs: Effects to Resource: Notes:	–
Optimal temperatures for yolk sac larvae are 13.5°C to 16°C. Mortality at >20°C.	Temperature in the BON tailrace and other locations in the lower Columbia River.	Data Outputs: BON temperature, Warrendale temperature.	Data Outputs: Incorporate into flow/temperature model for spawning and recruitment.	Data Outputs: Effects to Resource: Notes:	Data Outputs: Effects to Resource: Notes:	Data Outputs: Effects to Resource: Notes:	McCabe and Tracy, 1994 Wang et al., 1985

Affected Environment Important Relationships/Criteria	Affected Environment Metric	Environmental Consequences NAA	Environmental Consequences MO1	Environmental Consequences MO2	Environmental Consequences MO3	Environmental Consequences MO4	Notes
		Effects to Resource: The yolk-sac larvae life stage is short, but lab studies (Wang et al., 1985) found mortality at >20°C. Notes: Temperature affects rate of growth at this life stage, flows make habitats available.	Effects to Resource: Notes:	—	—	—	
Juvenile growth is optimal at 20°C to 24°C, no growth >26°C (Lebreton and Beamish, 2004). Juveniles can grow rapidly at 16°C during the first 4 months of life (in laboratory). In the wild, it would be dependent on temperature and food limitation (Brannon et al., 1984).	Temperature in the BON tailrace and other locations in the lower Columbia River.	Data Outputs: BON temperature, Warrendale temperature. Effects to Resource: Water temperatures exceed 20°C and juveniles grow rapidly. Notes:	Data Outputs: No change in temperature. But looked at BON river elevation changes in MO1, at most the change would be about 0.53 foot lower in MO1 compared to NAA. Effects to Resource: Would translate to a minimal effect on sturgeon feeding habitat. (See notes for relationship with river elevation with warm water temperatures.) Notes:	Data Outputs: Effects to Resource: Notes:	Data Outputs: Effects to Resource: Notes:	Data Outputs: No change. Effects to Resource: If flows decrease in summer, couples with temperatures to affect their metabolic needs relationship. (Higher temperatures = higher metabolic needs, but food could be limited if less flows? (Below BON is more important.) Notes:	McCabe and Tracy, 1994 Parsley and Beckman, 1994
Spawning – flows needed for successful spawning. 250 kcfs in Apr 1 to Jul 31 in MCN tailrace.	Flows MCN tailrace, BON >120 kcfs.	Data Outputs: Summary hydrograph shows 250 kcfs or above in median water years approximately [insert dates], and 25th percentile [insert dates]. Effects to Resource: Provides optimal spawning flows throughout spawning season in average years or above, and high enough flows to provide spawning in 75% of the time. Notes: Optimal temperature and flows in X days would be a good spawning year. Opportunity to look at if temperature is a correlate of flow in effects analysis modeling with both datasets. This criteria is also important for successful recruitment and larval drift.	Data Outputs: Effects to Resource: Notes:	Data Outputs: Effects to Resource: Notes:	Data Outputs: Effects to Resource: Notes:	Data Outputs: Effects to Resource: Notes:	Wang et al., 1985/1986 – Blaine Parket/Laura H. Also Parsley et al, 1993; McCabe and Tracy, 1994; Miller and Beckman, 1996; and BPA annual report 1986-050-00.

Affected Environment Important Relationships/Criteria	Affected Environment Metric	Environmental Consequences NAA	Environmental Consequences MO1	Environmental Consequences MO2	Environmental Consequences MO3	Environmental Consequences MO4	Notes
		This amount of flow and above 250 kcfs also maintains more consistent forebay/tailrace elevations and reduces chance of stranding/dewatering below BON. In years of extreme low flows and warm water, higher than typical adult mortalities have been documented (Olaf Langness document e.g., 2015).					
Appropriate temperature for embryo incubation time.	Optimal is 14°C to 16°C.	Data Outputs: May to Jul temperatures in tailraces below all 8 projects. Effects to Resource: Some years temperatures maintained, others may not be in NAA. Increase in egg mortality >18°C. Complete mortality >20°C. No regulations in place currently. Notes: Colin Chapman has a metric for temperature weighted usable area for spawning habitat (Parsley et al.); turbulence and flow not captured. Metric covers spawning and incubation; not covering once moving; stable temperatures also important.	Data Outputs: Effects to Resource: Notes:	Data Outputs: Effects to Resource: Notes:	Data Outputs: Effects to Resource: Notes:	Data Outputs: Effects to Resource: Notes:	Hildebrand et al., 2016; Counihan and Chapman, 2017 – Colin Chapman, ODFW.
Extreme low flows and higher reservoir temperatures can cause increased mortality of adults and females going atretic above 18°C. Incorporated into flow/temperature relationship.	Temperatures in reservoirs.	Data Outputs: Temperature flows in reservoirs. Effects to Resource: Extreme low flow or high temperature years would continue to result in periodic large mortality events. Notes: Recent – increased number of adult die-offs.	Data Outputs: Effects to Resource: Notes:	Data Outputs: Effects to Resource: Notes:	Data Outputs: Effects to Resource: Notes:	Data Outputs: Effects to Resource: Notes:	Wang et al., 1985/1986) – Blaine Paret/Laura H. Also Parsley et al., 1993; McCabe and Tracy, 1994; Miller and Beckman, 1986; and BPA annual report 1986-050-00.
S4: Modification to BON fish ladder.	–	Data Outputs: Effects to Resource: Could be more (slightly) effective passage for white sturgeon at BON.	Data Outputs: Effects to Resource: Notes:	Data Outputs: Effects to Resource: Notes:	Data Outputs: Effects to Resource: Notes:	Data Outputs: Effects to Resource: Notes:	McCabe and Tracy, 1994; Wang et al., 1985.

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Appendix E: Fish, Aquatic Macroinvertebrates, and Aquatic Habitat

Affected Environment Important Relationships/Criteria	Affected Environment Metric	Environmental Consequences NAA	Environmental Consequences MO1	Environmental Consequences MO2	Environmental Consequences MO3	Environmental Consequences MO4	Notes
		Notes:					
Improved fish passage turbines at JDA.	–	Data Outputs: Effects to Resource: Could have a positive effect for sturgeon in the JDA pool, lower impact mortality and injury. Idaho Power may have data on passage survival through the turbines. Effective for smaller fish (steelhead). Notes: The swim into draft tubes from downstream (slow roll).	Data Outputs: Effects to Resource: Notes:	Data Outputs: Effects to Resource: Notes:	Data Outputs: Effects to Resource: Notes:	Data Outputs: Effects to Resource: Notes:	McCabe and Tracy, 1994; Parsley et al., 1993
Temperature improvements in the Snake River – remind Snake River group to evaluate.	–	Data Outputs: Effects to Resource: Notes:	Data Outputs: Effects to Resource: Notes:	Data Outputs: Effects to Resource: Notes:	Data Outputs: Effects to Resource: Notes:	Data Outputs: Effects to Resource: Notes:	Van der Leeuw et al., 2006
Looked at all lamprey measures.	–	Data Outputs: Effects to Resource: Notes:	Data Outputs: Effects to Resource: Notes:	Data Outputs: Effects to Resource: Notes:	Data Outputs: Effects to Resource: Notes:	Data Outputs: Effects to Resource: Notes:	Miller and Beckman, 1996; Gadomski and Parsley, 2005b; and Golder and LGL, 2013.
Bull Trout							
Temperature would be the most important factor in the mainstem	Temperature measured at dams and tailraces; look at WQ presentations and briefs, if any change see temp files.	Currently there is limited migration and habitat use in mainstem	Same as NAA	Same as NAA	Same as NAA	Same as NAA	There is limited bull trout data since fishways are not measured at all times. There are also several unmonitored routes. Chances for mitigation include more tagging to monitor movement. Barrows et al 2016; BT and climate change from AFS 2008;
Importance of thermal refugia - recent paper from EPA.	Presence or absence of thermal refugia	Bull trout would continue to use thermal refugia at the tributaries listed in the notes.	NO change in surface temps from modeling results. Bull trout would continue to use thermal refugia as in the NAA.	NO change in surface temps from modeling results. Bull trout would continue to use thermal refugia as in the NAA.	NO change in surface temps from modeling results. Bull trout would continue to use thermal refugia as in the NAA.	NO change in surface temps from modeling results. Bull trout would continue to use thermal refugia as in the NAA.	Thermal Refugia includes Tribs at BON Pool: Wind River mouth, Herman Creek (OR side), Drano Lake, White Salmon, Klickitat, Deschutes (less so now due to Pelton RoundButte dam - warmer water than previously); at TDA Tailrace-Fifteenmile Creek; JDA pool - Willow Creek; further upstream not as well known - tribs typically warmer. Changes in surface temps could make thermal refugia even more important. Increases temp over time from 60's till now. Commonly >20°, thermal refugia is very important. Bull trout can be found in the summer in mainstem. Modeled temps will

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Affected Environment Important Relationships/Criteria	Affected Environment Metric	Environmental Consequences NAA	Environmental Consequences MO1	Environmental Consequences MO2	Environmental Consequences MO3	Environmental Consequences MO4	Notes
							not give level of detail to look at thermal refugia. Temps > leads to concentrations of fish in refugia pools, subject to angling impacts. Bigger tribes are probably ok. Groundwater recharge is limited.
Adults move downstream during fall and overwinter in reservoirs (Oct-Feb).	Presence of structures; may effect ability to pass dams safely,vailability of passage routes; lack of passage due to closure and winter maintenanc	Currently, populations are segmented by dams. Bull trout do move between areas, but could be delayed.	Structural measure to construct additional powerhouse surface passage routes at McNary - operate March 1 through August 31 could have minor benefits to downstream passage, but most bull trout have moved out of the mainstem when surface passage routes in use. McNary structure sweeps around dam and pulls surface passing fish over the spillway. Uses about 8kcfs attraction flow.	Additional powerhouse surface passage at MCN and JDA. Similar benefits as MO1 for McNary.	Additional powerhouse surface passage at MCN and JDA. Similar benefits as MO1 for McNary.	Additional powerhouse surface passage at MCN and JDA. Similar benefits as MO1 for McNary.	Move downstream more readily than upstream; can affect genetics with downward migrations. Access to winter passage can be important. Downstream migration in winter - passage is through turbines. Configuration of dams can affect passage. Timing of ice and trash sluiceway March 1-Dec. 15. Lack of habitat connectivity due to dams can lead to more isolated populations and less access to some habitats. There is generally a low knowledge of populations and limited data. BON and TDA bull trout use ice and trash sluiceway. Additional surface passage routes - may reduce turbine passage and increase survival. Extending the duration of juvenile bypass facilities could improve bull trout passage. Barrows et al 2016 - page 21
Movement through the turbines can cause injury/mortality.	Movement of fish during turbine operation.	Bull trout are more benthically oriented (compared to smolts), but do pass through turbines and survive. Also depends on size - blade strike incidence increases with increased size. An unknown number of bull trout would continue to pass through turbines with some mortality associated.	Turbine replacement measure would reduce blade strike rate and lead to better survival (physical and CFD models show an improvement for fish. At John Day - would provide safer passage for bull trout. Smaller fish less likely to strike. May be some improvement for bigger fish, if it increases the size of fish that can pass. Would be minor improvements in fish passage, but limited number of bull trout in the system leads to undetectable differences.	Same as MO1	Same as MO1	Same as MO1	Tracking in PUDs - show bull trout in the ladders or JBS, peak is in end of May/June - starting to move out due to warm temps. May be there in the winter (FMO) but move out is when they start to show up in ladder counts. Larger fish more likely to strike. Larger fish survival for turbine passage was 90% compared to spillway (97%) but with increased fallback with spillway determined about equal (24" steelhead in study, about the same as bull trout in the system). Normandeau 2014.

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Affected Environment Important Relationships/Criteria	Affected Environment Metric	Environmental Consequences NAA	Environmental Consequences MO1	Environmental Consequences MO2	Environmental Consequences MO3	Environmental Consequences MO4	Notes
Project configurations can affect bull trout susceptibility to predation.	Predation of bull trout - recovery of pit tags at avian colonies	Limited numbers of bull trout and lack of data make any detection unlikely. An Unknown number of bull trout may be exposed to increased predation.	No change from NAA.	No change from NAA.	No change from NAA.	No change from NAA.	Notches in spillway inserts could make any bull trout passing through weir notches could increase risk to predation by birds of smaller fish. Potentially greater risk to juveniles than adults. Keep in context - very few bull trout.
Fluctuations due to changes in BON pool can suppress vegetation on the delta at the mouth of the Klickitat and Hood River. This can make bull trout subject to predation when trying to access tributary or use thermal refugia.	River Stage Columbia R2 172.17 (Klickitat) and Columbia R2 170.31 (Hood River)	Change in river stage from current operation. The more the river drops, the more potential for decreased access.	No change from NAA.	No change from NAA.	No change from NAA.	No change from NAA.	Flat shallow areas where fish pass through - low water leads to suppressed vegetation. Bull trout use Klickitat for spawning and thermal refugia.
Temperature would be the most important factor in the mainstem	Temperature measured at dams and tailraces; look at WQ presentations and briefs, if any change see temp files.	Currently there is limited migration and habitat use in mainstem	Same as NAA	Same as NAA	Same as NAA	Same as NAA	There is limited bull trout data since fishways are not measured at all times. There are also several unmonitored routes. Chances fir mitigation include more tagging to monitor movement. Barrows et al 2016; BT and climate change from AFS 2008;
Importance of thermal refugia - recent paper from EPA.	Presence or absence of thermal refugia	Bull trout would continue to use thermal refugia at the tributaries listed in the notes.	NO change in surface temps from modeling results. Bull trout would continue to use thermal refugia as in the NAA.	NO change in surface temps from modeling results. Bull trout would continue to use thermal refugia as in the NAA.	NO change in surface temps from modeling results. Bull trout would continue to use thermal refugia as in the NAA.	NO change in surface temps from modeling results. Bull trout would continue to use thermal refugia as in the NAA.	Thermal Refugia includes Tribs at BON Pool: Wind River mouth, Herman Creek (OR side), Drano Lake, White Salmon, Klickitat, Deschutes (less so now due to Pelton RoundButte dam - warmer water than previously); at TDA Tailrace-Fifteenmile Creek; JDA pool - Willow Creek; further upstream not as well known - tribs typically warmer. Changes in surface temps could make thermal refugia even more important. Increases temp over time from 60's till now. Commonly >20°, thermal refugia is very important. Bull trout can be found in the summer in mainstem. Modeled temps will not give level of detail to look at thermal refugia. Temps > leads to concentrations of fish in refugia pools, subject to angling impacts. Bigger tribs are

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							probably ok. Groundwater recharge is limited.
Adults move downstream during fall and overwinter in reservoirs (Oct-Feb).	Presence of structures; may effect ability to pass dams safely, availability of passage routes; lack of passage due to closure and winter maintenanc	Currently, populations are segmented by dams. Bull trout do move between areas, but could be delayed.	Structural measure to construct additional powerhouse surface passage routes at McNary - operate March 1 through August 31 could have minor benefits to downstream passage, but most bull trout have moved out of the mainstem when surface passage routes in use. McNary structure sweeps around dam and pulls surface passing fish over the spillway. Uses about 8kcfs attraction flow.	Additional powerhouse surface passage at MCN and JDA. Similar benefits as MO1 for McNary.	Additional powerhouse surface passage at MCN and JDA. Similar benefits as MO1 for McNary.	Additional powerhouse surface passage at MCN and JDA. Similar benefits as MO1 for McNary.	Move downstream more readily than upstream; can affect genetics with downward migrations. Access to winter passage can be important. Downstream migration in winter - passage is through turbines. Configuration of dams can affect passage. Timing of ice and trash sluiceway March 1-Dec. 15. Lack of habitat connectivity due to dams can lead to more isolated populations and less access to some habitats. There is generally a low knowledge of populations and limited data. BON and TDA bull trout use ice and trash sluiceway. Additional surface passage routes - may reduce turbine passage and increase survival. Extending the duration of juvenile bypass facilities could improve bull trout passage. Barrows et al 2016 - page 21
Movement through the turbines can cause injury/mortality.	Movement of fish during turbine operation.	Bull trout are more benthically oriented (compared to smolts), but do pass through turbines and survive. Also depends on size - blade strike incidence increases with increased size. An unknown number of bull trout would continue to pass through turbines with some mortality associated.	Turbine replacement measure would reduce blade strike rate and lead to better survival (physical and CFD models show an improvement for fish. At John Day - would provide safer passage for bull trout. Smaller fish less likely to strike. May be some improvement for bigger fish, if it increases the size of fish that can pass. Would be minor improvements in fish passage, but limited number of bull trout in the system leads to undetectable differences.	Same as MO1	Same as MO1	Same as MO1	Tracking in PUDs - show bull trout in the ladders or JBS, peak is in end of May/June - starting to move out due to warm temps. May be there in the winter (FMO) but move out is when they start to show up in ladder counts. Larger fish more likely to strike. Larger fish survival for turbine passage was 90% compared to spillway (97%) but with increased fallback with spillway determined about equal (24" steelhead in study, about the same as bull trout in the system). Normandeau 2014.
Northern Pikeminnow							
Facts about NPM not relationships.	—	—	—	—	—	—	NPM Plasticity allows them to adapt to different environs; different life histories between free-flowing and impounded

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							river sections. Abundance from estuary to TDA is the highest; may be higher food avail. and habitat suitability in LCR. Further upstream project have lower lesser abundances. LCR Province Plan 2004-05 NWPCC
Water temperatures affect growth and recruitment. Spawning occurs in June-July when temps are ~65 oF, over clean rocky substrate in a range of depths in rivers and tribs.	Temperature	Temperatures not expected to change under the NAA. Current temperature profile is suitable for NPM spawning and life history.	No change from NAA	No change from NAA	No change from NAA	No change from NAA	Tolerates a wide range of water temperatures. LCR Province Plan 2004-05 NWPCC
Increased turbidity impacts ability to forage. May decrease feeding effectiveness if turbidity increases. Sight predators.	Turbidity/flow	Turbidity not expected to change. Would continue at approximately 2 mg/l. NPM predation not expected to change because of turbidity.	No change from NAA	No change from NAA	May see an increase in Turbidity during breaching, but this would be a negligible impact.	No change from NAA	LCR Province Plan 2004-05 NWPCC; gadomski?
Inundation of clean rocky substrate in a range of depths in rivers and tribs affects habitat availability.	—	Robust pikeminnow popn's still supported. Some year to year changes in population or size structure, but no long-term trend in abundance or distribution.	No change from NAA	No change from NAA	No change from NAA	No change from NAA	In reservoir areas, typically in tailraces of JDA, BON, TDA. Changes in flows - high flows followed by low flows could affect recruitment; Spawn June/July, freshet peak or dropping, stabilizing. Spawn at multiple depths so not limited to just shallow veg. Less sensitive to potential dewatering. Some tribs have viable pop'ns seeding pools downstream with juvies. Likely would not affect popn' level with pool fluctuations.
General info: When <300mm in length thier diet primarily invertebrates. As size increases, crayfish and fish become more important. Generally only older individuals eat a lot of salmon; salmon intake increases with pikeminnow size and salmonid abundance. Pikeminnow reward program objective to remove 10-20% of large NPM. Numbers are down from historic highs.	Pikeminnow suppression efforts	Exploitation rates vary from 7.5 to 17%. Under the no action alternative the NPM reward program would continue to remove ~ 12% of the population over 200mm in length.	Assuming pikeminnow program continues, there would be no change.	No change from NAA	No change from NAA	No change from NAA	Pikeminnow suppression targets >250 mm, use as a criteria? Targeted to reduce predation but balancing native pikeminnow populations healthy. Altering size structure. LCR Province Plan 2004-05 NWPCC Pikeminnow suppression plan?
General info: In 65 oF, eggs hatch in 7 days. Larvae are free swimming in 14 days.	Temperature at MCN Tailwater	Water temps reach 14C ~ early June. Current temps support successful spawning in late spring.	No change from NAA	No change from NAA	No change from NAA	No change from NAA	LCR Province Plan 2004-05 NWPCC

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Flows in July to distribute larval NPM downstream. Larvae drift downriver at night for 1-3 days in July. High flows can push them past rearing habitats. Rearing survival appears highest in low flow years, high shoreline water temps (>20 oC), and abundant veg.	Flows in tailraces	Abundance of pikeminnow recruitment would continue. Range of flows would continue and larval rearing would be variable depending on july flows.	No change from NAA	No change from NAA	No change from NAA	Increased spill may be a slight impact, depending on water levels (if high to begin with, could move pikeminnow out further), slight negative to pm. Minor increases in May flows in low water years and May/June in low (75% ile years) potentially benefit, but small. Small amount of water. Depends on daily/weekly fluctuations.	Larvae drift downriver at night for 1-3 days in July. Abundances highest in tailraces and below BON. Drift is brief prior to recruiting to shoreline sand, silt areas to rear. High, turbulent flows could blast them past the slackwater habitat where they begin to feed. Godomski et al. 2001 in Garcia 2014, LCR Province Plan 2004-05 NWPCC
Presence of walleye can reduce pikeminnow numbers (negatively correlated).	Walleye Populations	Walleye populations are stable in lower Columbia River. NPM would continue to thrive in Lower Columbia River.	Walleye numbers are not expected to change as a result of this alternative = no change in NPM competition.	Walleye numbers are not expected to change as a result of this alternative = no change in NPM competition.	Walleye numbers are not expected to change as a result of this alternative = no change in NPM competition.	Walleye numbers are not expected to change as a result of this alternative = no change in NPM competition.	Competition does not appear to limit production. Beamesderfer et al. 1996 in LCR Province Plan 2004-05 NWPCC; Steve Williams PSMFC - NP management program annual report
Removal program appears to reduce the population size structure, no compensation in productivity or competition has been observed. Ave exploitation = 12% of est. popln >250 mm.	NPM Removal	Some year to year change or size structure, but not a long-term trend in abundance or distribution.	No change from NAA	No change from NAA	No change from NAA	No change from NAA	Exploitation rates vary from 7.5 to 17%. Under the no action alternative the NPM reward program would continue to remove ~ 12% of the population over 200mm in length. Refs in LCR Province Plan 2004-05 NWPCC; Steve Williams citation
Water velocities from 3.28 to 4.27 ft/s could limit predation in high-salmon areas. Infer velocity ranges from flows where high flows could limit NPM.	Flows in tailraces	In high water years NPM may be limited in their ability to consume salmon in mainstream habitats.	No change from NAA	No change from NAA	No change from NAA	Increase in flows during May and June could limit NPM, but only occurs on low flow years that are already below average flow. No impact to NPM.	Increased flows could reduce salmonid predation. Velocities in bypasses, ladders. By excluding pikeminnow from areas where salmon are moving through structures. Thins out concentration of prey and predators. Mesa and Olson 1993 in LCR Province Plan 2004-05 NWPCC
Presence of juvenile shad increases growth of fish predators, including pikeminnow - overwinter survival	Shad expansion	Shad numbers have been increasing under the NAA. These populations will likely plateau in the future. Juvenile shad will provide additional forage for NPM.	Slight upstream potential for shad migration, but power operations could likely negate that effect. Likely no change to shad-pikeminnow abundance relationship from system operations.	No change from NAA	No change from NAA	Slight upstream potential for shad migration, but power operations could likely negate that effect. Likely no change to shad-pikeminnow abundance relationship.	Look at shad migration and reproduction based on flow; general idea is that shad do not migrate as far during high flow years. Fall forage availability - stronger and more fecund predators going into winter - more/stronger pikeminnow (and other predators). Mesa and Rose 2014

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Operational measure in MO1 designed to raise water levels during April and May in JDA to dissuade avian nesting. Could impact spawning fish as waters are pulled back down in June.	Water level fluctuations during spawning.	Water levels are not expected to fluctuate more than the one foot operating range under the NAA in the spring and summer. This minor change in water levels is not expected to impact NPM recruitment.	Designed for avian predation disruption. Would not be much difference for northern pikeminnow. (Note for walleye - they tend to spawn earlier than t (0.1ft change) hat time, so not affected). Habitat - tailrace spawners, below McNary not much habitat.) Note for smallmouth bass - small effect, would not be enough fluctuation to interrupt nesting success.	No change from NAA	No change from NAA	No change from NAA	–
Operational measure to provide additional flexibility up to one foot more in MO1.	Water level fluctuations during spawning.	Water levels are not expected to fluctuate more than the one foot operating range under the NAA in the spring and summer. This minor change in water levels is not expected to impact NPM recruitment.	Elevation April 1-June 1 would be 1 foot higher, but includes assumptions. Would likely actually fluctuate around. Otherwise same as NAA. Elevations no change to NAA in modeling, but additional flexibility in that range not likely to have any effects on pikeminnow, bass, walleye, etc.	No change from NAA	No change from NAA	No change from NAA	–
Walleye							
General info: Demersal fry, juveniles, adults prefer dim light; often found near substrate with cover during the day; if water too clear will feed at night.	Turbidity velocity	Reservoirs typically provide these conditions. Turbidity is low in the Columbia River.	No change from NAA	No change from NAA	No change from NAA	No change from NAA	Ali et al 1977 in McMahon et al. 1984
Spawning Nearshore over cobble and gravel in early spring in temperatures starting at 4C in 1-20 feet of water.	Suitable spawning temperatures and habitat	Reservoir habitats provide areas of cobble and gravel along the shoreline and in tributary inlets - Spring temperatures reach spawning temps in Late February	No change from NAA	No change from NAA	No change from NAA	No change from NAA	–
General info: Critical velocity for adults (~30 cm) is 74 cm/s; for juveniles at 20 cm is 60 cm/s	Velocity, hydrodynamics where potential changes could influence walleye juveniles.	High flows in spring would have negative impacts to larval Walleye by moving them from nursery areas.	Not in MO1 or MO4. Potential mitigation measure.	No change from NAA	No change from NAA	Not in MO1 or MO4. Potential mitigation measure.	Proposed research - fluctuations of McNary pool to interrupt spawning success near lower end of Bateman Island in Yakima delta. Poor swimmers when newly hatched, flush out to cooler, faster water when they can't survive it. Hard river level needed to McNary lock in most flow years would impede ability to fluctuate. Causeway is perfect rearing area for walleye.

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							Measure to increase flows would impact this. Refs in McMahon et al. 1984 McMichael (proposal to increase flows during walleye spawn/hatch - sweeping out)
Adult optimum temp is 20 -24C; they avoid temps higher; growth ceases <12C. LCR below BON has fastest growth.	Temperature Profile	Warmer temps reach optimum growth in late summer. Growth ceases in late fall early winter. Reservoir conditions have favored walleyes, would continue. Numbers are increasing, would expect to continue.	No change from NAA	No change from NAA	No change from NAA	Water Temperatures would be slightly higher in late summer and early fall on dry years as MCN flows are depleted and less water is moved down river in these years.	Larvals do better in warm calm water. Really big spawning years (calm, low water, warm) Refs in McMahon et al. 1984
Adult abundance greatest at DO levels >3-5 mg/L; can tolerate 2 mg/L for short time; embryos need >3.4 mg/L	DO	DO levels would be suitable for all life stages. Ranging from 9-11 ppm.	No change from NAA	No change from NAA	Possible deficit during drawdown and possibly longer depending on TSS concentrations. Not expected to have more than a minor impact to walleye.	No change from NAA	—
Spawning preference for clean rocky uneven surfaces (gravel/rubble) to protect from predators, or vegetation mats, with moderate waves/good circulation to keep eggs oxygenated and free of sediment; poor embryo survival on sand, muck, or detritus.	Shoreline velocity, turbidity	Abundant areas of gravel and cobble for Walleye Spawning	See similar relationship in pikeminnow.	Same as MO1	Same as MO1	Same as MO1	Similar to pikeminnow discussion - dropping water levels after spawning. But not much ability to affect at a pop'n level. Homogenized flow regime, reduced variability in seasonal/daily flows.
High embryo production associated with stable or rising water levels in spring to maximize littoral area and minimize embryo stranding	water levels/flow	Water levels are not expected to fluctuate by more than two feet. No measurable impact to fish populations.	Not enough change to make a difference.	No change from NAA	No change from NAA	Same as MO1. Not much water compared to the area.	—
Spawning occurs March - early May or when water temp is 4.4 - 10 oC	Temperature in tailrace areas	Water tempertures would reach 4C about March 10 and would reach 10C about the first of May. Tempteratures are ideal for Walleye spawning.	No change from NAA	Not enough change to make a difference.	Not enough change to make a difference.	Not enough change to make a difference.	LCR Province Plan 2004-05 NWPCC
Walleye tend to spawn in areas of moderate current below McNary, JDA, TDA to keep the water free of silt, which can suffocate eggs. Too much current will wash eggs ashore.	Velocity/flow	High flow water years may negatively impact eggs and larvae by washing to unsuitable habitats.	Minor flow changes, very small areas it might make a difference (i.e. mitigation areas).	No change from NAA	No change from NAA	No change from NAA	LCR Province Plan 2004-05 NWPCC
Gonad maturation in females requires winter temps <10C (50F)	Temperature	Water tempertures below 10C from Mid November to early	No change from NAA	No change from NAA	No change from NAA	No change from NAA	Refs in McMahon et al. 1984

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		May. Water tempertures are suitable for maturation.					
Optimum temps are 6-9C for fertilization and 9-15 oC for incubation	Temperature	Water temperatures reach 6C mid March and 9C late April; and 15C on early June. Temperatures are suitable for fertilization and incubation	No change from NAA	No change from NAA	No change from NAA	No change from NAA	Refs in McMahon et al. 1984
Poor embryo survival when spring temps increase too slowly (<0.18 oC/day), or are cold weather fronts, cold reservoir releases, etc.	Temperature	Cold Springs will have an unknown impact on embryo survival. No known operations in Basin D that would impact spring water temperatures.	No change from NAA	No change from NAA	No change from NAA	No change from NAA	All Run of river reservoirs. Moot point.
Conditions that slow fry growth (low temp, low zooplankton abund, delayed hatching) increase overwinter mortality (small fish fare worse)	Tempertures Productivity	Adequate temperatures for growth and survival. Zooplankton abundant in most years.	Slightly more growth in summer could support to slightly higher shad populations or other fish that eat the same. All yoy fish could potentially increase, but could not quantify and likely very minimal effect.	No change from NAA	Zooplankton possibly depressed during breach and until new equilibrium established	No change from NAA	Changes in pop'n structure (pikeminnow crew incidental catch). JDA - more smaller fish, likely harvest-driven. No limit on walleye. Series of low water scenarios could reduce growth/condition factor due to reduced forage base.
Newly-hatched fry require food (plankton) at 3 days after hatching, no fins for several weeks so limited mobility (surface oriented); need low velocities. This life stage population-limiting below BON.	Velocity	Hi flow years would have negative impacts to larval Walleye. However, there are no known operations that are expected to change flows.	No change from NAA	No change from NAA	No change from NAA	No change from NAA	Opportunity to limit production LCR Province Plan 2004-05 NWPCC
Most abundant in tailraces, less mid-res., least abund. in forebays. Below BON, found down to RkM 137, but most numerous from RkM 178-234.	—	There is an increasing trend in recent years	No change from NAA	No change from NAA	No change from NAA	No change from NAA	Increasing trend in pikeminnow sampling. Fishing crews - last five years walleye and bass numbers have increased. 2015 extremely productive water year, not sure if seeing an increasing trend, or just a boom from one water year and moving through time Proportional stock density not as strong in JDA, increased in BON and TDA (to some degree). Williams et al 2017 - Julie sent link., P. 142-Creel data.
General info: Demersal fry, juveniles, adults prefer dim light; often found near substrate with cover during the day; if water too clear will feed at night.	Turbidity velocity	Reservoirs typically provide these conditions. Turbidity is low in the Columbia River.	No change from NAA	No change from NAA	No change from NAA	No change from NAA	Ali et al 1977 in McMahon et al. 1984

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Smallmouth Bass							
Spawning occurs mid-May -late June, when water temps hit 15.6-18.3C (60-65F).	Temperature	–	No change from NAA	No change from NAA	No change from NAA	Slight increase in temperature in summer and fall of dry years as augmentation water is depleted.	LCR Province Plan 2004-05 NWPCC
Spawning habitat = shoreline areas, gravel/rubble as well as sand/rock substrate. Usually in 2-5 ft water near submerged cover (log, boulder, etc.). Flooding (low temp/siltation) or water level drop results in reproductive failure.	Flow/velocity	Protected bays, low velocity, off-channel sloughs.	Could potentially be affected by increased elevation April 1 - June 1 from flexibility measure. May affect individual nests but they vary in depth of spawning, likely not an affect at population scale. Spawn mid-May to mid-June; depends on temps so changes annually. The later half of spawners may be affected.	No change from NAA	No change from NAA	No change from NAA	Protected bays, low velocity, off-channel sloughs, increased elevations and cooler flows tend to interrupt incubation... males excavate depression and guard it. May desert if rapid decline in water temp or water level. Fidelity to nest sites. LCR Province Plan 2004-05 NWPCC Wydoski and Whitney 2003
"Winter starvation period" occurs below 7-10 C; small fish die first; must grow big enough in first year to survive overwinter --> warm summer temps required for growth.	Temperature	SMB would face a winter dormant period from Mid to late November to mid to late April. Some smaller and less fit fish would not survive.	No change from NAA	No change from NAA	No change from NAA	No change from NAA	Juvenile shad are important fall forage for smb. Shuter et al. 1980, Henderson and Foster 1956 in Brown et al. 1990 Mesa and Rose...
Discharge has greater impact than temp during nursery season. Fry displaced from nests at 8 mm/s in lab. High velocity during first year in general inhibits growth; energy expended for movement and not feeding; pushed out of prime forage areas. Less overwinter survival.	Velocity	High Flow years would have negative impacts to SMB fry. There are no measures in the NAA alternative that would change flow.	No change from NAA	No change from NAA	No change from NAA	No change from NAA	Larimore 2000, Simonson and Swenson 1990 in Brown et al 2009
pH 6.0 - 9.0; prefers 7.9-8.1	pH	pH is generally between 6.5 and 8.4 in this reach of the river (WQ Appendices). These values are suitable for SMB. There are no measures that should change pH.	No change from NAA	No change from NAA	No change from NAA	No change from NAA	Brown et al. 2009
DO requirement >6.0 mg/L; spawning >7 mg/L; embryos >6.5 mg/L	DO	DO is between 7.5 and 10 (WQ Appendices). These values are suitable for all life stages of SMB.	No change from NAA	No change from NAA	No change from NAA	No change from NAA	Brown et al. 2009
Optimal adult temp 21.1-26.7C (70-80F). Sudden drops in temp may cause mortality. Some adults will occupy high temp waters if food/cover available.	Temperature / flow / shallow water areas inundated by high pool elevations	Optimum water temperatures for SMB are not reached until mid summer and occur July and August only. Temperatures are cooler than optimum and SMB growth will be reduced. No Measures are	No change from NAA	No change from NAA	No change from NAA	MO4 temperatures may be warmer in late summer and fall on dry years as augmentation waters are depleted. Higher temperatures would benefit SMB.	Refs in Brown et al. 2009; LCR Province Plan 2004-05 NWPCC

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		included that should change temperature.					
Prefer gravel or rocky substrate, rooted vegetation, or artificial structures (pilings etc.) for cover. Can tolerate mild salinities. Below BON, few numbers but occur down to RkM 71.	Suitable Substrate	Under the NAA there are suitable substrates for SMB in all reservoirs. Rip Rap and some rocky areas and inlets provide these habitats.	Predation reduction measure may inundate other habitats and then dewater them in June.	No change from NAA	No change from NAA	No change from NAA	Zimmerman and Parker 1995 in LCR Province Plan 2004-05 NWPCC
Optimal water velocity for yearlings 10 mm/s	Flows	High Flow years would have negative impacts to SMB yearlings. There are no measures in the NAA alternative that would change flow.	No change from NAA	No change from NAA	No change from NAA	No change from NAA	–
Clear water required to spy prey; increasing turbidity decreases prey availability.	Turbidity	Turbidity levels are generally low for the lower Columbia River. Total Suspended Solids range from 1 to 5 ppm with higher levels in spring. Visibiltiy should not be impacted in most years.	No change from NAA	No change from NAA	No change from NAA	No change from NAA	Brown et al. 2009
Not all bass spawn each year; poorly understood. If temperatures drop during incubations males may abandon the nest. Males that leave nest are not replaced and brood dies.	Temperature Drops	On some unknown number of years sudden drops in water temperature may induce nest abandonment.	No change from NAA	No change from NAA	No change from NAA	No change from NAA	–
Spawning time dependent on temp and rate of temp increase. Spawning often initiates at 15-16C.	Temperature	Water temperatures reach 15C in mid May. Water temperatures are suitable for SMB spawning.	No change from NAA	No change from NAA	No change from NAA	No change from NAA	Refs in Brown et al. 2009
Nests excavated in mud, sand, or gravel. Parental care required to prevent predation of eggs, larvae (15 days) --> removal by fishing impacts survival. Current exploitation rates in the LCR are low.	Harvest	An unknown number of adult males will be harvested and nests will fail. No measures are included that would change harvest.	No change from NAA	No change from NAA	No change from NAA	No change from NAA	Brown et al. 2009, Refs in LCR Province Plan 2004-05 NWPCC
Shift to fish prey during first year very important for caloric intake and growth needs.	Prey availability	Adequate prey are available for juvenile SMB. No measures are included that would change prey.	No change from NAA	No change from NAA	No change from NAA	No change from NAA	Refs in Brown et al. 2009.
By 3 in in length, eating almost any life form in sight. Crayfish most common item. Diet consists of sculpin, cyprinids, suckers, and sand rollers. Juvenile salmon are eaten during migration (<100 mm). Negative correlation	See above.	–	–	–	–	–	SMB in JDA system and below Tumwater Falls. Also invasive crayfish in JDA system. Shifts in predation dynamics is key, Pikeminnow program - no clear signals yet, but do have year to year changes. Design of

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Affected Environment Important Relationships/Criteria	Affected Environment Metric	Environmental Consequences NAA	Environmental Consequences MO1	Environmental Consequences MO2	Environmental Consequences MO3	Environmental Consequences MO4	Notes
between size of bass and salmon consumption (small eat the most). Competition for food not a limiting factor.							sport reward program isn't designed to detect SMB, but just pikeminnow removed. Brown et al. 2009, Refs in LCR Province Plan 2004-05 NWPCC
Smallmouth make and tend nests until hatching. If nest is disturbed or increases by more than 4' of depth, they will abandon the nest.	Pool/river elevations	Water depth will not fluctuate by more than 2 feet in the NAA. Effects to nesting bass are expected to be negligible.	Water levels may fluctuate by as much as 4 feet under MO1. There may be minor impacts to nesting SMB.	No change from NAA	No change from NAA	No change from NAA	–
Gamefish							
Catfish	Definitely a predator, not well-studied, can be a key predator below some dams. Caught below McNary and JDA more than BON. Ccats predation on smolts (Vigg) - stomach contents and observations. Catfish not as prevalent, but 2nd highest level of predator on salmonids. Channel catfish not as susceptible to capture with methods used. Walleye and bass dominant gamefish.						
Predator Evaluation	1. Level of salmonid predator, 2. Relative abundance. Pikeminnow - high predator and high abundance, Channel Catfish - high predator, low abundance, SMB - less predator, high abundance, Walleye - high predator, low abundance (at the time).						

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CHAPTER 4 - RAW DATA

Table 4-1. Raw COMPASS data for Upper Columbia spring Chinook for each of the 80 modeled years by Alternative

Year	Species	InRivSurvUC	InRivSurvLCol	InRivSurv	MedDayRIS	MedDayConfl	MedDayBON	Mean Travel Time	Mean MigRate	Mean Temp	Mean Flow	Mean FSpill	Mean Gas	UC Travel Time	UCMig Rate	UCTemp	UCFlow	UCFSpill	UCGas	LCTravelTime	LCMigRate	LCTemp	LCFlow	LCFSpill	LCGas	BonFlow
NAA																										
1929	Chinook_1	0.6904	0.6624	0.4566	133.5	148.1	152.62	29.143	28.649	13.910	163.67	0.7157	9.6040	20.302	9.745	12.004	99.14	0.5559	1.9926	7.0678	24.801	15.250	204.15	0.7861	13.7010	213.74
1930	Chinook_1	0.7285	0.5909	0.4298	132.34	144.39	147.48	22.825	30.253	15.068	149.57	0.7077	9.3519	14.588	12.585	13.121	108.96	0.5199	2.1624	6.4951	25.677	16.489	176.05	0.7981	13.1655	180.98
1931	Chinook_1	0.7264	0.5723	0.4151	132.43	144.38	146.91	23.325	30.034	15.115	142.80	0.7151	9.5657	15.047	12.226	13.187	103.62	0.5355	2.8520	6.5361	25.445	16.564	167.44	0.8025	13.0225	173.76
1932	Chinook_1	0.7210	0.7227	0.5203	131.81	143.3	147.27	22.285	31.819	13.289	259.03	0.6860	11.9397	14.454	13.807	11.629	174.84	0.4943	3.9177	6.0187	30.206	14.393	313.97	0.7743	16.0093	322.77
1933	Chinook_1	0.7289	0.7188	0.5232	131.85	143.23	149.2	21.514	31.685	13.864	253.76	0.6891	11.6296	13.708	13.568	12.226	165.55	0.4954	2.7673	6.0194	29.505	14.983	309.70	0.7783	16.2142	322.42
1934	Chinook_1	0.7445	0.6218	0.4623	131.39	139.92	141.72	17.006	34.229	15.014	250.81	0.6878	12.2342	9.800	18.230	13.260	213.61	0.4979	6.4751	5.4432	31.434	16.312	274.55	0.7811	14.9576	280.19
1935	Chinook_1	0.7235	0.6981	0.5043	132.26	143.63	148.65	22.800	30.748	13.933	207.60	0.6872	9.8206	14.700	12.842	12.236	146.37	0.4866	1.6098	6.3189	27.641	15.111	246.20	0.7802	14.1886	255.72
1936	Chinook_1	0.7174	0.6377	0.4568	132.09	144.17	145.99	22.467	32.518	14.148	255.29	0.6938	12.1901	15.107	13.251	12.217	173.80	0.5063	4.6040	5.5769	31.760	15.587	307.30	0.7814	16.0255	317.22
1937	Chinook_1	0.7035	0.6820	0.4791	132.9	146.04	151.01	26.984	28.902	13.663	169.50	0.7038	9.3162	18.144	10.865	11.928	111.14	0.5268	1.5314	7.0507	24.868	14.852	206.59	0.7822	13.4876	216.61
1938	Chinook_1	0.7251	0.7082	0.5127	131.78	143.55	147.84	21.641	31.975	13.711	247.61	0.6859	11.5123	13.928	13.941	11.989	165.24	0.4933	3.2926	5.9190	30.092	14.879	300.12	0.7743	15.6813	309.47
1939	Chinook_1	0.7052	0.5825	0.4102	132.43	146.69	148.21	25.776	30.276	14.347	180.22	0.6923	9.5024	17.648	12.042	12.207	132.23	0.4922	1.8641	6.3567	26.909	15.988	210.53	0.7861	13.6219	216.31
1940	Chinook_1	0.7335	0.6170	0.4519	131.89	143.27	145.86	21.119	31.684	14.770	200.10	0.6805	9.5427	13.351	13.918	12.907	142.57	0.4750	1.4289	6.0099	28.536	16.132	236.69	0.7737	13.9788	243.59
1941	Chinook_1	0.7349	0.6496	0.4766	132.13	142.84	147.3	22.083	30.178	14.708	152.60	0.7104	9.3389	13.744	13.099	13.141	103.68	0.5322	2.0459	6.5791	25.514	15.825	183.72	0.7940	13.1957	189.43
1942	Chinook_1	0.7029	0.7281	0.5110	132.54	146.51	151.52	26.437	29.387	13.063	205.79	0.6960	9.9932	17.794	11.234	11.416	132.19	0.5101	1.6231	6.8282	26.347	14.175	253.22	0.7805	14.5340	261.78
1943	Chinook_1	0.7221	0.7170	0.5170	131.68	144.06	148.8	22.134	31.826	13.647	248.16	0.6867	11.3797	14.345	13.810	11.902	168.08	0.4950	2.9154	5.9953	29.812	14.825	299.12	0.7759	15.6863	309.39
1944	Chinook_1	0.7098	0.6601	0.4678	132.94	145.69	151.22	26.332	28.711	14.140	143.15	0.7197	9.2441	17.516	10.651	12.430	95.57	0.5526	1.9860	7.0445	24.142	15.369	173.86	0.7992	13.1149	180.06
1945	Chinook_1	0.7089	0.6821	0.4828	132.7	145.31	149.58	25.160	30.742	14.035	211.93	0.6961	10.3448	17.154	11.517	12.214	130.19	0.5173	2.0191	6.2333	28.528	15.280	263.92	0.7735	14.7410	275.31
1946	Chinook_1	0.7223	0.7168	0.5170	131.54	142.2	146.01	20.945	33.041	13.610	283.56	0.6926	13.4108	13.501	14.700	11.858	208.79	0.5138	6.5734	5.6486	32.142	14.787	332.36	0.7765	16.5312	341.77
1947	Chinook_1	0.7359	0.6442	0.4733	131.52	141.72	144.24	19.440	33.659	14.727	255.83	0.6905	11.8624	12.258	15.202	12.923	174.77	0.5025	3.8777	5.4200	32.509	16.031	308.46	0.7781	15.9258	316.45
1948	Chinook_1	0.7183	0.7454	0.5346	132.06	143.7	147.23	21.258	34.516	13.505	392.91	0.7242	17.4105	14.526	13.948	11.709	240.26	0.5431	6.3788	4.9385	36.435	14.715	488.92	0.8256	23.9489	509.49
1949	Chinook_1	0.7303	0.7011	0.5112	131.62	142.1	145.59	20.338	33.141	13.895	283.00	0.6996	13.0093	13.056	14.458	12.290	184.97	0.5196	4.2822	5.4916	32.499	15.019	344.67	0.7861	17.3310	358.80
1950	Chinook_1	0.7105	0.7292	0.5174	132.27	145.11	149.88	23.921	31.503	13.393	272.60	0.6908	12.0603	16.023	12.773	11.626	174.99	0.5003	2.8540	6.0984	30.011	14.581	333.18	0.7815	16.7059	349.74
1951	Chinook_1	0.7350	0.7171	0.5263	131.45	141.17	145.47	19.138	33.248	13.818	273.42	0.6887	12.4871	11.686	15.936	12.241	198.17	0.5033	4.8536	5.6561	31.659	14.884	322.02	0.7752	16.1468	332.41
1952	Chinook_1	0.7174	0.7247	0.5191	131.74	143.51	147.27	22.205	32.439	13.234	282.08	0.7010	13.6785	14.696	13.599	11.588	185.37	0.5287	6.0247	5.6929	32.026	14.352	344.63	0.7833	17.4203	354.31
1953	Chinook_1	0.7234	0.7433	0.5368	132.12	142.76	148.99	22.299	31.117	13.266	248.76	0.6908	11.5021	14.346	12.860	11.900	160.42	0.5029	2.8960	6.1351	29.383	14.181	305.47	0.7762	15.9067	318.29
1954	Chinook_1	0.7094	0.7467	0.5289	132.2	144.2	148.98	23.803	31.347	12.898	274.51	0.6939	12.6350	15.831	12.869	11.288	190.35	0.5128	4.7256	6.1475	30.093	13.981	328.49	0.7791	16.5187	340.97
1955	Chinook_1	0.7019	0.7386	0.5176	132.79	145.4	151.44	26.095	30.027	13.083	235.48	0.6956	11.0627	17.731	11.306	11.479	150.77	0.5176	2.5334	6.5517	27.813	14.163	288.84	0.7738	15.4557	302.98
1956	Chinook_1	0.7232	0.7465	0.5391	131.57	142.91	146.34	19.867	34.016	13.065	356.31	0.7141	16.1392	12.804	15.447	11.449	241.03	0.5410	7.1216	5.2354	34.681	14.138	429.87	0.8058	20.7796	445.86
1957	Chinook_1	0.7219	0.7378	0.5318	131.56	142.89	146.22	21.072	33.392	12.984	339.84	0.7100	15.4931	13.805	14.430	11.472	214.05	0.5339	6.1285	5.4359	34.065	13.997	419.86	0.7991	20.3894	434.88
1958	Chinook_1	0.7127	0.7130	0.5074	132.33	144.65	147.84	23.157	32.597	13.509	299.14	0.7016	13.6486	15.712	12.843	11.833	182.38	0.5245	4.4273	5.6442	32.702	14.667	373.49	0.7859	18.3748	388.97

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Year	Species	InRivSurvUC	InRivSurvLCol	InRivSurv	MedDayRIS	MedDayConfl	MedDayBON	Mean Travel Time	Mean MigRate	Mean Temp	Mean Flow	Mean FSpill	Mean Gas	UC Travel Time	UCMig Rate	UCTemp	UCFlow	UCFSpill	UCGas	LCTravelTime	LCMigRate	LCTemp	LCFlow	LCFSpill	LCGas	BonFlow
1959	Chinook_1	0.7312	0.7225	0.5275	131.52	141.96	147.22	20.115	32.545	13.785	266.40	0.6808	11.3687	12.470	14.859	12.150	192.81	0.4873	2.8046	5.8525	30.701	14.891	313.84	0.7698	15.6862	324.16
1960	Chinook_1	0.7125	0.7227	0.5142	132.02	143.85	149.14	23.994	30.662	13.216	234.04	0.6791	10.5805	15.691	13.046	11.460	167.74	0.4763	2.2626	6.4971	27.830	14.397	275.34	0.7735	14.8716	285.87
1961	Chinook_1	0.7340	0.7270	0.5328	131.44	141.82	147.04	19.820	32.598	13.493	289.53	0.6866	12.4836	12.046	15.519	12.007	212.44	0.5006	4.0417	5.9644	30.684	14.488	338.61	0.7709	16.6262	347.43
1962	Chinook_1	0.7201	0.7066	0.5081	131.92	143.97	148.55	22.798	31.580	13.773	236.74	0.6756	10.7376	14.862	13.384	11.982	165.48	0.4711	2.5387	6.1523	29.336	14.982	284.19	0.7668	15.0055	288.98
1963	Chinook_1	0.7264	0.7015	0.5088	132.1	144.12	148.83	22.406	31.056	14.008	211.46	0.6976	10.4709	14.396	12.868	12.389	131.91	0.5172	2.1897	6.2285	28.402	15.102	263.20	0.7783	14.8462	270.23
1964	Chinook_1	0.7065	0.7213	0.5089	132.62	145.23	150.04	24.722	31.613	13.689	273.65	0.7001	12.2612	16.926	12.194	11.820	171.71	0.5224	2.8973	6.0153	30.327	14.960	338.75	0.7823	17.2142	350.38
1965	Chinook_1	0.7275	0.7323	0.5319	131.71	142.52	147.61	21.062	32.388	13.420	267.76	0.6860	11.7497	13.511	13.794	11.858	172.94	0.4974	2.6073	5.7417	31.583	14.491	330.45	0.7729	16.4807	335.80
1966	Chinook_1	0.7160	0.6117	0.4373	132.31	145.49	148.35	24.031	30.718	14.590	194.70	0.6832	9.3796	15.881	12.650	12.499	145.24	0.4775	1.3841	6.3944	27.144	16.110	227.27	0.7783	13.7574	233.24
1967	Chinook_1	0.6998	0.7237	0.5057	132.39	146.45	150.75	25.512	31.450	13.288	291.25	0.6984	13.0268	17.487	12.547	11.448	191.18	0.5217	4.0575	6.2228	30.116	14.515	356.05	0.7799	17.5907	365.78
1968	Chinook_1	0.7264	0.6856	0.4973	132.41	143.36	148.13	22.264	31.000	14.521	203.27	0.7009	10.2337	14.296	13.091	12.910	137.69	0.5240	2.3544	6.2064	27.607	15.649	243.31	0.7827	14.3324	254.99
1969	Chinook_1	0.7319	0.7111	0.5197	131.43	141.47	145.4	19.495	33.781	13.856	300.61	0.6932	13.4401	12.258	15.435	12.252	207.11	0.5151	5.0342	5.4440	33.328	14.959	361.80	0.7771	17.5322	366.88
1970	Chinook_1	0.6980	0.7226	0.5036	132.93	146.41	151.15	26.742	30.129	13.044	243.47	0.7071	11.7626	18.423	10.824	11.538	139.01	0.5497	3.0572	6.4981	28.682	14.053	311.05	0.7748	16.2276	319.27
1971	Chinook_1	0.7202	0.7443	0.5352	131.46	142.24	146.67	20.504	33.900	13.119	337.93	0.7057	15.6813	13.357	14.690	11.459	225.22	0.5365	7.4560	5.3268	34.859	14.226	412.92	0.7912	19.7641	418.93
1972	Chinook_1	0.7360	0.7425	0.5457	131.38	140.96	144.88	18.238	35.004	13.646	358.39	0.7149	15.7334	11.369	16.887	12.101	248.77	0.5426	6.1960	5.0651	35.426	14.672	432.68	0.8049	20.9224	433.02
1973	Chinook_1	0.7167	0.6757	0.4836	132.58	144.39	149.49	25.128	28.733	13.776	155.28	0.7134	9.0790	16.263	11.250	12.239	104.63	0.5403	1.4432	7.0696	24.257	14.868	188.21	0.7938	13.2238	193.48
1974	Chinook_1	0.7341	0.7408	0.5430	131.35	140.35	145.23	18.057	35.056	13.625	347.52	0.7109	16.5088	11.160	16.723	11.974	241.87	0.5467	9.0075	5.0962	35.644	14.727	418.73	0.7940	20.2472	422.85
1975	Chinook_1	0.7072	0.7444	0.5256	132.42	144.13	149.72	24.456	31.214	13.043	268.49	0.6938	12.2104	16.518	12.225	11.412	168.54	0.5107	3.2644	6.1241	30.060	14.135	333.11	0.7790	16.8372	342.66
1976	Chinook_1	0.7122	0.7504	0.5336	131.8	143.53	147.98	23.080	31.977	12.783	286.92	0.6964	13.2352	15.419	13.232	11.181	190.54	0.5189	4.9718	5.8287	31.545	13.860	353.11	0.7800	17.4931	354.95
1977	Chinook_1	0.7248	0.6484	0.4692	132.46	143.23	148.39	24.120	28.708	14.308	130.89	0.7198	9.4953	15.204	11.934	12.739	101.73	0.5380	3.3015	7.1408	23.151	15.450	149.47	0.8119	12.5938	155.37
1978	Chinook_1	0.7216	0.7120	0.5130	131.72	144.09	148.57	22.724	30.779	13.447	224.41	0.6819	10.2318	14.540	13.510	11.770	159.30	0.4792	1.8973	6.3779	27.729	14.556	265.35	0.7761	14.6841	273.99
1979	Chinook_1	0.7127	0.7007	0.4987	132.23	144.91	148.87	24.640	29.892	13.204	209.79	0.6926	10.1511	16.210	12.117	11.619	139.86	0.5006	1.8899	6.6110	26.960	14.294	255.25	0.7804	14.5429	262.72
1980	Chinook_1	0.7235	0.7305	0.5277	131.68	141.4	146.16	21.073	32.381	13.395	272.42	0.6993	12.9220	13.572	13.707	11.785	194.20	0.5263	5.6812	5.6928	31.616	14.503	326.86	0.7790	16.4960	331.45
1981	Chinook_1	0.7311	0.6988	0.5101	132.18	142.5	147.07	21.038	32.094	14.438	231.17	0.6917	10.8875	13.433	13.731	12.852	153.55	0.5074	2.6453	5.8369	29.942	15.553	281.41	0.7743	15.1366	289.56
1982	Chinook_1	0.7271	0.7279	0.5285	131.81	142.6	147.08	20.865	33.203	13.751	293.17	0.6931	13.1501	13.553	14.050	12.121	185.65	0.5143	4.2629	5.5205	33.007	14.870	365.26	0.7738	17.6661	370.19
1983	Chinook_1	0.7301	0.7335	0.5348	131.75	143.01	148.69	21.375	31.562	13.452	247.35	0.6870	11.2824	13.506	13.554	11.989	149.99	0.4981	2.2879	6.0583	29.759	14.430	309.95	0.7710	16.0116	317.95
1984	Chinook_1	0.7081	0.7170	0.5070	132.44	145.96	150.37	24.886	31.558	13.656	245.22	0.6974	11.4787	17.156	11.755	11.788	131.29	0.5316	2.1919	5.9449	30.654	14.931	319.66	0.7672	16.4422	325.76
1985	Chinook_1	0.7106	0.6876	0.4878	132.37	145.57	149.31	24.812	30.385	13.642	213.17	0.6915	10.1001	16.562	12.233	11.919	143.92	0.4976	1.6333	6.4558	27.540	14.839	256.90	0.7817	14.5719	265.72
1986	Chinook_1	0.7311	0.6940	0.5067	131.8	143.6	148.55	21.427	31.551	14.075	226.53	0.6885	10.8013	13.537	13.653	12.505	141.52	0.4998	2.1559	6.1064	29.028	15.144	281.59	0.7732	15.3911	285.54
1987	Chinook_1	0.7402	0.6014	0.4445	131.56	140.74	142.51	19.082	32.834	15.218	212.49	0.6873	10.4011	11.660	15.481	13.412	172.09	0.4871	3.2431	5.6759	29.845	16.573	240.18	0.7822	14.0647	243.54
1988	Chinook_1	0.7093	0.6835	0.4841	132.53	145.84	150.49	25.815	29.319	13.660	182.60	0.6861	9.2676	16.971	11.888	11.961	132.85	0.4837	1.4018	7.0508	25.135	14.812	215.32	0.7784	13.5043	221.31
1989	Chinook_1	0.7210	0.6855	0.4935	131.76	143.27	147.37	22.746	31.033	13.783	214.58	0.6807	9.9521	14.662	13.465	11.986	160.71	0.4752	1.8494	6.2970	27.970	15.019	250.77	0.7761	14.2715	253.17
1990	Chinook_1	0.7396	0.6186	0.4568	131.64	142.08	145.36	19.619	32.694	15.235	215.87	0.6781	10.0123	12.117	15.151	13.300	162.59	0.4710	1.9841	5.7639	29.562	16.658	251.19	0.7745	14.2865	254.33
1991	Chinook_1	0.7328	0.7175	0.5250	131.52	142.23	147.14	20.458	31.976	13.799	245.68	0.6806	11.0332	12.514	14.812	12.241	180.62	0.4854	3.0201	6.1516	29.343	14.839	289.78	0.7696	15.1412	289.39
1992	Chinook_1	0.7403	0.5936	0.4388	131.71	142.18	144.67	20.231	31.796	15.258	178.94	0.6862	9.7126	12.428	14.689	13.427	139.23	0.4782	2.6641	6.0607	27.798	16.618	205.66	0.7842	13.3781	208.41

Columbia River System Operations Environmental Impact Statement
Appendix E: Fish, Aquatic Macroinvertebrates, and Aquatic Habitat

Year	Species	InRivSurvUC	InRivSurvLCol	InRivSurv	MedDayRIS	MedDayConfl	MedDayBON	Mean Travel Time	Mean MigRate	Mean Temp	Mean Flow	Mean FSpill	Mean Gas	UC Travel Time	UCMig Rate	UCTemp	UCFlow	UCFSpill	UCGas	LCTravelTime	LCMigrate	LCTemp	LCFlow	LCFSpill	LCGas	BonFlow
1993	Chinook_1	0.6946	0.6884	0.4775	133.11	146.31	149.65	26.965	30.513	13.473	230.94	0.7097	11.2815	18.899	11.041	11.711	140.90	0.5499	2.7488	6.2658	28.982	14.705	291.40	0.7792	15.8017	296.43
1994	Chinook_1	0.7307	0.5933	0.4329	131.9	143.17	145.43	21.824	31.102	14.878	178.54	0.6893	9.1357	13.877	13.428	12.914	136.08	0.4831	1.2341	6.1957	27.326	16.358	205.59	0.7872	13.4125	210.92
1995	Chinook_1	0.7251	0.7226	0.5232	132.2	143.26	148.58	22.415	31.064	13.581	226.05	0.6917	10.5613	14.433	12.889	12.088	141.92	0.5067	2.0107	6.1785	28.899	14.599	280.16	0.7735	15.0986	289.54
1996	Chinook_1	0.7322	0.7272	0.5316	131.56	141.89	146.13	19.625	33.126	13.761	277.11	0.6908	12.5923	12.268	15.106	12.162	190.06	0.5098	4.3652	5.5608	32.066	14.893	333.86	0.7768	16.7347	341.74
1997	Chinook_1	0.7375	0.7443	0.5481	131.38	140.25	143.63	17.189	36.334	13.669	392.61	0.7298	18.3020	10.734	17.315	12.091	273.89	0.5708	9.7560	4.6518	38.380	14.729	473.17	0.8157	22.9379	476.53
1998	Chinook_1	0.7315	0.7142	0.5217	131.59	142.03	146.67	20.404	32.971	13.942	268.79	0.6967	12.4257	12.999	14.129	12.338	168.72	0.5244	3.9609	5.6170	32.282	15.027	335.37	0.7727	16.7205	342.80
1999	Chinook_1	0.7365	0.7234	0.5320	131.58	142.36	147.76	19.700	32.519	13.773	261.82	0.6857	11.8784	12.012	15.089	12.213	172.96	0.4986	3.2930	5.8905	30.569	14.799	320.20	0.7702	16.2374	328.01
2000	Chinook_1	0.7308	0.6289	0.4589	131.77	143.5	146.38	21.143	31.817	14.624	207.77	0.6809	9.9437	13.424	14.141	12.653	151.80	0.4763	2.0209	5.9609	28.712	16.052	243.22	0.7754	14.1850	250.93
2001	Chinook_1	0.7205	0.6538	0.4703	132.6	144.76	149.43	24.612	28.993	14.247	144.34	0.7170	9.6946	15.865	11.515	12.655	99.85	0.5457	3.1480	6.9731	24.199	15.375	172.87	0.7977	13.0619	179.87
2002	Chinook_1	0.7184	0.7104	0.5096	131.8	144.05	148.5	22.591	31.717	13.742	254.40	0.6840	11.3298	14.693	13.766	11.931	182.72	0.4875	2.9665	6.1138	29.360	14.962	299.92	0.7766	15.5760	309.36
2003	Chinook_1	0.7293	0.7058	0.5140	131.74	143.31	148.71	21.611	30.932	13.604	228.88	0.6905	10.6711	13.519	13.504	12.091	150.82	0.4997	2.0030	6.2874	28.098	14.639	275.88	0.7786	15.1100	292.98
2004	Chinook_1	0.7302	0.6864	0.5005	131.76	143.46	148.42	22.183	30.531	14.010	196.88	0.6851	9.6845	13.918	13.312	12.412	131.72	0.4853	1.5647	6.4811	26.782	15.103	234.02	0.7758	13.9616	254.35
2005	Chinook_1	0.7352	0.6667	0.4894	132.12	142.23	145.7	21.205	31.316	14.635	191.57	0.6938	9.6880	13.339	13.678	13.042	128.92	0.4997	1.6019	6.1041	27.910	15.766	232.58	0.7831	14.0444	237.85
2006	Chinook_1	0.7159	0.7174	0.5128	131.87	144.46	147.59	22.356	32.679	13.435	294.75	0.7004	13.2360	14.972	13.705	11.786	192.77	0.5254	4.1637	5.5766	32.351	14.561	362.19	0.7848	17.9553	369.38
2007	Chinook_1	0.7398	0.6867	0.5072	131.56	141.1	144.95	19.659	32.083	14.455	215.54	0.6844	9.7367	11.912	15.421	12.891	166.13	0.4787	1.6194	5.9759	28.602	15.547	248.01	0.7829	14.0878	253.38
2008	Chinook_1	0.7052	0.7145	0.5031	132.76	145.39	149.41	24.712	32.007	13.827	278.83	0.7104	13.0909	17.109	11.980	12.026	159.48	0.5545	3.9519	5.8236	31.458	15.037	354.22	0.7815	17.6496	370.93
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1929	Chinook_1	0.6905	0.6693	0.4615	133.48	148.39	152.25	28.562	29.012	13.963	157.27	0.7726	10.0478	20.379	9.672	12.134	94.07	0.6256	2.0603	6.4081	25.811	15.278	196.83	0.8698	14.4974	206.14
1930	Chinook_1	0.7255	0.5826	0.4220	132.43	145.32	147.7	23.143	30.220	15.152	137.14	0.7578	9.3674	15.218	12.047	13.213	96.51	0.5988	2.1011	6.1842	26.028	16.595	163.48	0.8561	13.3431	168.52
1931	Chinook_1	0.7250	0.5729	0.4148	132.49	145.13	146.73	23.150	30.311	15.158	134.16	0.7765	10.0234	15.331	11.997	13.259	95.18	0.6092	3.0524	6.0757	26.352	16.612	158.49	0.8935	13.7489	164.98
1932	Chinook_1	0.7200	0.7296	0.5246	131.84	143.35	147.26	22.237	31.903	13.277	255.83	0.7025	11.5486	14.610	13.693	11.616	172.20	0.5182	3.1629	5.8128	30.559	14.387	310.47	0.7957	15.8969	319.07
1933	Chinook_1	0.7283	0.7258	0.5278	131.84	143.61	149.01	21.260	31.930	13.886	248.90	0.7210	11.5637	13.767	13.497	12.275	160.79	0.5392	2.4649	5.7047	30.202	14.993	304.78	0.8224	16.3421	317.25
1934	Chinook_1	0.7450	0.6227	0.4632	131.39	139.93	141.65	16.877	34.355	15.059	251.22	0.7011	11.6696	9.760	18.322	13.372	213.40	0.5221	5.3506	5.3522	31.719	16.332	275.30	0.7940	14.7693	281.31
1935	Chinook_1	0.7229	0.7041	0.5082	132.32	144.01	148.56	22.566	30.996	13.943	204.25	0.7252	9.8988	14.839	12.746	12.267	143.11	0.5390	1.3974	5.9448	28.365	15.113	242.77	0.8310	14.5336	252.24
1936	Chinook_1	0.7169	0.6310	0.4517	132.27	144.62	146.16	22.772	32.414	14.312	241.38	0.7074	11.2169	15.521	12.961	12.384	160.28	0.5288	3.0330	5.4732	31.639	15.786	293.14	0.7964	15.5267	302.99
1937	Chinook_1	0.7010	0.6871	0.4809	133	146.52	150.88	26.919	29.040	13.652	157.84	0.7682	9.8316	18.636	10.529	11.927	100.92	0.6095	1.8633	6.4919	25.531	14.841	193.81	0.8730	14.1897	203.69
1938	Chinook_1	0.7245	0.7138	0.5164	131.82	143.73	147.8	21.653	32.032	13.720	243.60	0.7036	11.1380	14.080	13.794	11.980	160.96	0.5209	2.6106	5.7795	30.349	14.902	296.31	0.7952	15.5459	305.62
1939	Chinook_1	0.7022	0.5834	0.4090	132.56	147.22	148	25.972	30.512	14.415	172.75	0.7470	9.8658	18.265	11.801	12.360	123.97	0.5587	1.8773	5.9330	27.739	16.037	203.41	0.8664	14.2592	209.64
1940	Chinook_1	0.7313	0.6144	0.4486	132.06	143.81	145.9	21.278	31.777	14.819	192.96	0.7202	9.4845	13.799	13.547	12.978	135.09	0.5336	1.1975	5.7202	29.100	16.189	229.69	0.8228	14.0948	236.82
1941	Chinook_1	0.7342	0.6646	0.4872	132.26	142.84	146.85	21.538	30.829	14.694	160.25	0.7597	9.8419	13.758	13.197	13.166	108.90	0.5877	2.0031	6.0173	27.102	15.783	192.93	0.8718	14.1045	199.23
1942	Chinook_1	0.6991	0.7348	0.5129	132.74	147.05	151.95	26.772	29.428	13.085	199.05	0.7291	10.0511	18.483	10.840	11.435	124.08	0.5644	1.8371	6.4734	26.785	14.205	247.08	0.8165	14.5115	255.98
1943	Chinook_1	0.7222	0.7259	0.5234	131.69	144.05	148.4	21.832	32.066	13.626	246.52	0.7098	11.1798	14.296	13.809	11.871	167.66	0.5247	2.2862	5.7417	30.434	14.813	297.10	0.8088	15.8393	306.77
1944	Chinook_1	0.7071	0.6626	0.4678	133.03	146.37	151.53	26.490	28.718	14.118	135.54	0.7604	9.2087	17.983	10.334	12.368	88.69	0.6158	1.9047	6.7358	24.419	15.368	165.61	0.8474	13.1771	171.80
1945	Chinook_1	0.7082	0.6837	0.4835	132.76	145.97	149.76	25.162	30.683	14.092	194.44	0.7434	10.3312	17.470	11.305	12.332	115.16	0.5841	1.8530	5.9183	28.585	15.320	244.52	0.8342	14.9981	255.61

Columbia River System Operations Environmental Impact Statement
Appendix E: Fish, Aquatic Macroinvertebrates, and Aquatic Habitat

Year	Species	InRivSurvUC	InRivSurvLCol	InRivSurv	MedDayRIS	MedDayConfl	MedDayBON	Mean Travel Time	Mean MigRate	Mean Temp	Mean Flow	Mean FSpill	Mean Gas	UC Travel Time	UCMig Rate	UCTemp	UCFlow	UCFSpill	UCGas	LCTravelTime	LCMigRate	LCTemp	LCFlow	LCFSpill	LCGas	BonFlow
1946	Chinook_1	0.7215	0.7229	0.5208	131.56	142.27	146.01	21.019	33.039	13.619	280.16	0.7010	12.7683	13.666	14.522	11.836	205.32	0.5265	5.3699	5.5585	32.265	14.821	329.05	0.7871	16.2949	338.52
1947	Chinook_1	0.7353	0.6457	0.4740	131.53	141.97	144.09	19.378	33.740	14.761	253.74	0.7010	11.2258	12.341	15.103	12.959	172.66	0.5199	2.5089	5.2746	32.801	16.080	306.31	0.7903	15.7884	314.47
1948	Chinook_1	0.7187	0.7502	0.5384	132.03	143.82	147.44	21.167	34.533	13.544	388.04	0.7260	16.7201	14.504	14.027	11.786	236.17	0.5519	5.5980	4.8679	36.451	14.743	483.27	0.8240	23.2028	503.91
1949	Chinook_1	0.7301	0.7085	0.5165	131.61	142.28	145.7	20.261	33.189	13.857	281.00	0.7071	12.6933	13.042	14.432	12.202	184.38	0.5340	3.8373	5.4287	32.642	15.005	341.74	0.7936	17.1248	355.66
1950	Chinook_1	0.7109	0.7349	0.5216	132.32	145.24	149.93	23.679	31.710	13.466	267.11	0.7096	11.7222	16.072	12.710	11.743	170.32	0.5298	2.4301	5.8067	30.594	14.646	327.40	0.8036	16.4875	343.56
1951	Chinook_1	0.7345	0.7240	0.5310	131.43	141.3	145.5	19.175	33.256	13.797	271.44	0.7008	11.9638	11.804	15.808	12.177	195.93	0.5235	3.7115	5.5751	31.775	14.886	320.01	0.7885	16.0604	330.49
1952	Chinook_1	0.7173	0.7300	0.5229	131.77	143.57	147.25	22.249	32.475	13.292	277.63	0.7064	13.1326	14.831	13.482	11.597	180.83	0.5385	5.1308	5.6062	32.136	14.449	340.19	0.7880	17.1068	349.94
1953	Chinook_1	0.7212	0.7505	0.5405	132.21	143.16	149.04	22.383	31.244	13.239	244.97	0.7209	11.4474	14.711	12.603	11.823	156.17	0.5470	2.5993	5.8550	29.903	14.180	301.71	0.8143	16.0639	314.76
1954	Chinook_1	0.7080	0.7549	0.5337	132.32	144.28	149.01	23.773	31.473	12.914	270.42	0.7110	12.3238	16.065	12.682	11.293	186.72	0.5399	4.2434	5.8835	30.568	14.010	324.24	0.7992	16.3710	336.49
1955	Chinook_1	0.7000	0.7465	0.5218	132.91	145.67	151.29	26.012	30.242	13.084	230.07	0.7344	11.1159	18.097	11.102	11.466	145.87	0.5717	2.2974	6.1035	28.520	14.177	283.06	0.8251	15.7804	297.11
1956	Chinook_1	0.7215	0.7510	0.5410	131.59	142.93	146.6	20.172	33.985	13.148	349.93	0.7115	15.3031	13.097	15.172	11.469	234.84	0.5476	6.2107	5.2533	34.693	14.267	423.48	0.7953	19.7898	439.33
1957	Chinook_1	0.7175	0.7439	0.5329	131.69	142.96	146.42	21.508	33.321	13.056	332.67	0.7167	15.2212	14.352	13.737	11.511	206.56	0.5562	6.2499	5.3291	34.365	14.099	413.50	0.7973	19.7367	428.45
1958	Chinook_1	0.7122	0.7194	0.5116	132.36	144.78	148.1	23.136	32.719	13.546	293.81	0.7144	13.3057	15.885	12.707	11.839	178.07	0.5505	4.1584	5.4520	33.097	14.731	367.63	0.7958	17.9601	382.89
1959	Chinook_1	0.7317	0.7301	0.5334	131.52	142.16	147.06	19.855	32.720	13.795	264.55	0.7034	11.2277	12.428	14.883	12.187	191.23	0.5206	2.3916	5.6337	31.150	14.887	311.59	0.7984	15.7853	321.99
1960	Chinook_1	0.7120	0.7312	0.5198	132.07	143.92	149.03	23.766	30.837	13.187	230.96	0.7072	10.4339	15.814	12.948	11.442	165.36	0.5170	1.9945	6.1423	28.431	14.365	271.87	0.8096	14.8703	282.06
1961	Chinook_1	0.7321	0.7352	0.5374	131.49	142.27	147.42	20.052	32.547	13.465	283.93	0.7098	12.2804	12.475	15.022	11.949	205.29	0.5365	3.6311	5.7679	30.969	14.474	333.88	0.7982	16.5649	343.02
1962	Chinook_1	0.7184	0.7129	0.5114	132.06	144.31	148.7	22.866	31.659	13.773	230.68	0.7047	10.5255	15.211	13.119	11.975	158.93	0.5134	2.1251	5.8703	29.785	14.994	278.26	0.8034	15.0074	283.31
1963	Chinook_1	0.7248	0.7076	0.5121	132.21	144.58	149.07	22.363	31.242	14.033	208.11	0.7288	10.4983	14.689	12.637	12.434	128.34	0.5629	2.0201	5.8920	29.067	15.123	260.14	0.8175	15.0879	267.04
1964	Chinook_1	0.7046	0.7286	0.5126	132.79	145.51	150.31	24.764	31.777	13.739	270.70	0.7224	12.2299	17.286	11.941	11.930	168.08	0.5588	2.8992	5.6948	30.989	14.990	336.35	0.8065	17.1417	348.04
1965	Chinook_1	0.7258	0.7399	0.5363	131.79	142.89	147.87	21.272	32.325	13.391	263.85	0.6978	11.5367	13.809	13.519	11.785	168.71	0.5166	2.3153	5.6549	31.641	14.485	326.68	0.7860	16.3817	332.11
1966	Chinook_1	0.7164	0.6115	0.4374	132.34	145.53	147.72	23.618	31.015	14.651	192.04	0.7162	9.6335	15.882	12.640	12.630	142.59	0.5268	1.8178	5.9757	27.974	16.159	224.45	0.8192	13.8433	230.53
1967	Chinook_1	0.6978	0.7315	0.5097	132.46	146.79	151.01	25.571	31.497	13.324	282.85	0.7171	12.6806	17.878	12.304	11.544	184.69	0.5498	3.4925	5.8893	30.477	14.529	346.46	0.8026	17.3984	355.67
1968	Chinook_1	0.7259	0.6908	0.5008	132.5	143.52	148.21	22.221	31.084	14.564	198.87	0.7293	10.0617	14.472	12.936	13.043	133.60	0.5665	2.1194	5.9850	27.996	15.647	238.67	0.8176	14.2475	250.32
1969	Chinook_1	0.7312	0.7188	0.5248	131.45	141.71	145.65	19.620	33.749	13.836	296.88	0.7004	13.1391	12.436	15.242	12.185	203.03	0.5270	4.6108	5.3929	33.392	14.964	358.20	0.7849	17.3432	363.46
1970	Chinook_1	0.6967	0.7275	0.5061	133.07	146.76	151.32	26.705	30.200	13.088	234.66	0.7276	11.3178	18.697	10.686	11.550	131.20	0.5796	2.3882	6.1882	28.945	14.126	301.41	0.8004	15.9861	309.65
1971	Chinook_1	0.7201	0.7502	0.5394	131.48	142.24	146.55	20.538	33.944	13.219	335.90	0.7047	15.0225	13.409	14.627	11.570	222.86	0.5428	6.4602	5.3128	34.945	14.337	411.41	0.7837	19.2479	417.28
1972	Chinook_1	0.7358	0.7488	0.5501	131.39	141.09	145.15	18.227	35.005	13.647	355.78	0.7184	15.1637	11.383	16.863	12.109	247.35	0.5572	5.6904	5.0385	35.484	14.667	429.35	0.8019	20.1159	429.45
1973	Chinook_1	0.7164	0.6907	0.4941	132.6	144.49	149.02	24.355	29.406	13.698	165.56	0.7586	9.7602	16.154	11.423	12.145	112.56	0.5923	1.6607	6.4034	25.850	14.786	199.65	0.8645	14.2031	206.00
1974	Chinook_1	0.7335	0.7475	0.5475	131.36	140.64	145.59	18.262	34.912	13.656	343.62	0.7102	15.7418	11.355	16.399	12.012	236.82	0.5498	7.7678	5.1069	35.525	14.760	415.64	0.7902	19.7480	419.86
1975	Chinook_1	0.7072	0.7523	0.5312	132.43	144.21	149.58	24.278	31.312	13.029	263.76	0.7094	11.7510	16.562	12.189	11.379	165.83	0.5367	2.4748	5.9010	30.352	14.134	327.32	0.7961	16.5838	336.15
1976	Chinook_1	0.7121	0.7579	0.5389	131.83	143.53	148.01	23.037	31.995	12.810	281.56	0.7029	12.7315	15.464	13.167	11.185	186.42	0.5324	4.3102	5.7414	31.625	13.906	347.12	0.7849	17.0952	348.55
1977	Chinook_1	0.7228	0.6528	0.4711	132.53	143.61	148.38	24.168	28.808	14.312	121.48	0.7766	9.7907	15.650	11.572	12.788	92.34	0.6101	3.4017	6.7410	23.739	15.434	139.67	0.8926	13.2037	145.85
1978	Chinook_1	0.7220	0.7178	0.5175	131.68	144.01	148.33	22.321	31.105	13.514	225.02	0.7068	10.1534	14.463	13.513	11.876	159.29	0.5185	1.6711	6.0517	28.555	14.615	266.31	0.8054	14.7300	275.18
1979	Chinook_1	0.7096	0.7046	0.4992	132.39	145.25	148.95	24.870	29.975	13.261	200.84	0.7318	10.1969	16.844	11.585	11.657	130.87	0.5573	1.6366	6.2102	27.551	14.374	246.53	0.8293	14.8513	254.00

Columbia River System Operations Environmental Impact Statement
Appendix E: Fish, Aquatic Macroinvertebrates, and Aquatic Habitat

Year	Species	InRivSurvUC	InRivSurvLCol	InRivSurv	MedDayRIS	MedDayConfl	MedDayBON	Mean Travel Time	Mean MigRate	Mean Temp	Mean Flow	Mean FSpill	Mean Gas	UC Travel Time	UCMig Rate	UCTemp	UCFlow	UCFSpill	UCGas	LCTravelTime	LCMigrate	LCTemp	LCFlow	LCFSpill	LCGas	BonFlow
1980	Chinook_1	0.7219	0.7384	0.5322	131.7	141.68	146.37	21.228	32.314	13.354	267.77	0.7091	12.3760	13.815	13.451	11.710	189.37	0.5398	4.6642	5.6046	31.674	14.478	322.25	0.7928	16.3053	326.98
1981	Chinook_1	0.7307	0.7065	0.5155	132.26	142.68	147.05	20.949	32.253	14.479	226.46	0.7230	10.7673	13.593	13.615	12.987	148.97	0.5532	2.2830	5.5868	30.476	15.545	276.61	0.8137	15.2405	284.73
1982	Chinook_1	0.7263	0.7349	0.5330	131.9	142.9	147.42	20.892	33.249	13.758	288.01	0.7063	12.8027	13.694	13.891	12.148	181.29	0.5402	3.8259	5.4054	33.285	14.864	360.01	0.7852	17.3739	364.60
1983	Chinook_1	0.7288	0.7423	0.5401	131.78	143.34	148.69	21.403	31.629	13.406	242.98	0.7130	11.0531	13.721	13.338	11.912	146.63	0.5380	1.7967	5.8700	30.126	14.396	305.33	0.8025	16.0018	312.72
1984	Chinook_1	0.7056	0.7238	0.5100	132.64	146.27	150.7	25.089	31.738	13.718	242.79	0.7194	11.3403	17.626	11.507	11.909	126.89	0.5664	1.8700	5.6782	31.318	14.978	318.68	0.7921	16.4838	325.03
1985	Chinook_1	0.7101	0.6937	0.4918	132.39	145.74	149.29	24.572	30.589	13.666	207.06	0.7247	10.0505	16.713	12.105	11.926	138.76	0.5447	1.3572	6.0647	28.154	14.883	250.26	0.8247	14.7876	258.79
1986	Chinook_1	0.7293	0.7011	0.5106	131.78	144.06	148.71	21.445	31.731	14.032	226.03	0.7211	10.8751	13.833	13.565	12.434	139.05	0.5491	2.0316	5.8261	29.619	15.117	281.66	0.8131	15.6433	286.39
1987	Chinook_1	0.7408	0.6031	0.4461	131.6	140.98	142.45	18.993	32.948	15.280	202.08	0.7313	10.5321	11.801	15.314	13.546	162.36	0.5385	3.1508	5.4446	30.291	16.608	229.29	0.8485	14.3948	232.71
1988	Chinook_1	0.7094	0.6812	0.4825	132.47	146.26	150.53	25.620	29.170	13.683	161.23	0.7354	9.3432	17.127	11.621	11.978	116.59	0.5571	1.8084	6.6982	25.032	14.853	190.69	0.8389	13.3844	195.41
1989	Chinook_1	0.7205	0.6931	0.4987	131.79	143.37	146.91	22.508	31.327	13.775	212.89	0.7200	10.0642	14.788	13.334	11.968	158.45	0.5248	1.4779	5.9322	28.821	15.022	249.40	0.8328	14.7541	251.96
1990	Chinook_1	0.7395	0.6198	0.4576	131.66	142.24	145.24	19.477	32.888	15.294	211.11	0.7137	10.0638	12.245	15.040	13.447	157.24	0.5230	1.9373	5.4905	30.212	16.679	246.64	0.8195	14.4398	250.03
1991	Chinook_1	0.7326	0.7249	0.5303	131.53	142.43	147.23	20.246	32.143	13.807	242.61	0.7032	10.7125	12.555	14.805	12.264	179.06	0.5197	2.3779	5.8974	29.793	14.839	285.76	0.7977	15.0840	284.92
1992	Chinook_1	0.7391	0.5915	0.4366	131.82	142.52	144.69	20.317	31.857	15.332	170.71	0.7293	10.1148	12.792	14.329	13.578	130.61	0.5429	3.3805	5.7818	28.283	16.666	197.54	0.8366	13.5706	200.49
1993	Chinook_1	0.6918	0.6956	0.4805	133.27	146.62	149.8	27.195	30.555	13.463	225.78	0.7313	11.0293	19.390	10.767	11.693	136.51	0.5833	2.1108	6.0039	29.331	14.703	285.70	0.8056	15.8446	290.63
1994	Chinook_1	0.7284	0.5852	0.4256	132.21	144.13	145.8	22.175	30.961	14.956	161.56	0.7362	9.4165	14.467	12.920	13.006	120.56	0.5539	1.8891	5.9577	27.381	16.450	187.70	0.8436	13.5022	192.67
1995	Chinook_1	0.7233	0.7298	0.5271	132.27	143.64	148.69	22.456	31.147	13.543	222.32	0.7200	10.5859	14.741	12.629	12.012	138.14	0.5493	1.8680	5.9116	29.333	14.577	276.46	0.8081	15.3050	285.88
1996	Chinook_1	0.7317	0.7358	0.5376	131.58	141.89	146.15	19.627	33.166	13.749	274.76	0.7012	11.8714	12.364	15.015	12.179	187.77	0.5249	2.8395	5.4643	32.279	14.862	331.42	0.7906	16.5120	339.34
1997	Chinook_1	0.7361	0.7503	0.5515	131.4	140.47	144.01	17.607	36.111	13.671	389.70	0.7242	17.5456	11.066	16.826	12.030	269.36	0.5740	8.9284	4.7417	38.150	14.768	471.28	0.7989	22.0168	475.02
1998	Chinook_1	0.7315	0.7237	0.5287	131.6	142.22	146.7	20.124	33.240	13.933	272.28	0.7034	12.2170	12.865	14.293	12.355	171.82	0.5346	3.5214	5.4691	32.869	15.002	338.83	0.7832	16.6209	346.47
1999	Chinook_1	0.7350	0.7296	0.5354	131.61	142.87	147.87	20.000	32.538	13.824	255.24	0.7081	11.3866	12.518	14.595	12.276	165.10	0.5284	2.1465	5.6863	30.981	14.857	314.62	0.8004	16.2018	322.46
2000	Chinook_1	0.7310	0.6298	0.4597	131.73	143.57	145.94	20.790	32.165	14.635	209.85	0.7094	9.8874	13.349	14.215	12.680	153.74	0.5171	1.6795	5.6791	29.574	16.069	245.44	0.8127	14.3521	253.24
2001	Chinook_1	0.7177	0.6581	0.4716	132.67	145.41	149.34	24.606	29.173	14.218	136.50	0.7759	10.1384	16.342	11.149	12.597	92.46	0.6195	3.2950	6.4883	24.969	15.367	164.46	0.8823	13.8257	171.77
2002	Chinook_1	0.7170	0.7176	0.5138	131.89	144.34	148.77	22.611	31.829	13.728	249.52	0.7089	11.0330	15.009	13.497	11.914	176.96	0.5248	2.3712	5.8164	29.913	14.956	295.65	0.8070	15.5410	305.29
2003	Chinook_1	0.7281	0.7135	0.5188	131.78	143.54	148.37	21.543	31.116	13.569	225.82	0.7204	10.5408	13.750	13.308	12.029	148.31	0.5397	1.5339	5.9867	28.738	14.618	272.54	0.8193	15.2885	289.38
2004	Chinook_1	0.7279	0.6898	0.5014	131.85	144.01	148.62	22.326	30.495	13.983	187.49	0.7262	9.7060	14.341	12.908	12.358	122.97	0.5489	1.6175	6.1990	27.068	15.089	224.14	0.8245	14.0220	244.28
2005	Chinook_1	0.7329	0.6730	0.4925	132.31	142.52	145.95	21.340	31.470	14.654	185.77	0.7389	9.9374	13.810	13.280	13.093	122.17	0.5623	1.5493	5.7677	28.632	15.771	227.44	0.8425	14.5712	232.87
2006	Chinook_1	0.7159	0.7234	0.5171	131.89	144.43	147.62	22.277	32.831	13.480	293.25	0.7076	12.9465	15.008	13.625	11.788	190.67	0.5409	3.7835	5.4640	32.743	14.639	361.22	0.7896	17.6872	368.62
2007	Chinook_1	0.7397	0.6934	0.5121	131.6	141.16	144.88	19.472	32.265	14.457	212.64	0.7166	9.7996	11.981	15.313	12.910	163.41	0.5205	1.3470	5.7183	29.173	15.536	244.88	0.8281	14.4217	250.36
2008	Chinook_1	0.7033	0.7214	0.5066	132.94	145.66	149.7	24.817	32.130	13.872	274.56	0.7284	12.8813	17.481	11.714	12.126	155.49	0.5860	3.6908	5.5548	32.029	15.066	350.16	0.7993	17.4795	366.46
MO2																										
1929	Chinook_1	0.6911	0.6468	0.4467	133.4	148.04	153.17	29.424	29.578	13.966	162.14	0.6598	4.1697	20.249	9.879	12.025	97.48	0.5377	0.7893	7.5614	24.505	15.339	202.74	0.6614	5.2214	212.19
1930	Chinook_1	0.7264	0.5660	0.4108	132.32	145.06	148.56	23.637	30.846	15.165	139.63	0.6511	4.2416	15.070	12.378	13.153	99.07	0.5142	0.7345	6.9878	24.654	16.647	166.02	0.6603	5.4527	170.70
1931	Chinook_1	0.7262	0.5531	0.4014	132.38	144.68	147.71	23.703	30.817	15.167	137.79	0.6550	4.2600	15.140	12.367	13.191	99.35	0.5180	0.7266	6.9809	24.673	16.657	161.91	0.6663	5.5334	167.86
1932	Chinook_1	0.7225	0.7176	0.5181	131.71	143.01	146.57	22.195	33.489	13.291	260.95	0.6587	4.3625	14.302	14.218	11.596	176.63	0.4876	0.7406	6.2404	31.677	14.416	315.70	0.7101	5.6529	324.87

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Appendix E: Fish, Aquatic Macroinvertebrates, and Aquatic Habitat

Year	Species	InRivSurvUC	InRivSurvLCol	InRivSurv	MedDayRIS	MedDayConfl	MedDayBON	Mean Travel Time	Mean MigRate	Mean Temp	Mean Flow	Mean FSpill	Mean Gas	UC Travel Time	UCMig Rate	UCTemp	UCFlow	UCFSpill	UCGas	LCTravelTime	LCMigRate	LCTemp	LCFlow	LCFSpill	LCGas	BonFlow
1933	Chinook_1	0.7283	0.7140	0.5196	131.76	143.52	150.55	21.742	33.080	13.849	253.13	0.6612	5.1240	13.773	13.743	12.172	162.38	0.4833	0.8751	6.3408	30.430	14.990	310.31	0.7192	6.7236	324.07
1934	Chinook_1	0.7457	0.6122	0.4562	131.29	139.79	141.97	16.982	35.837	15.031	251.43	0.6467	4.6401	9.659	18.873	13.323	214.11	0.4828	1.2726	5.7169	32.469	16.309	275.35	0.6910	5.8851	280.79
1935	Chinook_1	0.7241	0.6849	0.4956	132.16	143.72	149.44	23.093	31.944	13.898	207.77	0.6396	4.1916	14.618	13.119	12.149	147.01	0.4621	0.7153	6.8514	27.993	15.110	246.11	0.6819	5.3709	255.56
1936	Chinook_1	0.7177	0.6209	0.4453	132.19	144.41	146.53	22.920	33.902	14.314	243.41	0.6580	4.3039	15.426	13.299	12.339	162.67	0.4945	0.7201	5.8765	32.563	15.804	294.87	0.7005	5.6389	304.84
1937	Chinook_1	0.7031	0.6623	0.4653	132.86	146.07	151.92	27.703	29.520	13.697	162.72	0.6402	4.2232	18.306	10.889	11.906	105.31	0.5090	0.7685	7.7670	23.932	14.927	199.15	0.6374	5.2883	208.85
1938	Chinook_1	0.7264	0.7035	0.5106	131.69	143.41	148.19	21.579	33.530	13.706	247.82	0.6584	4.3459	13.831	14.254	11.957	163.76	0.4852	0.9105	6.1100	31.354	14.892	301.17	0.7113	5.4857	310.87
1939	Chinook_1	0.7035	0.5611	0.3944	132.44	146.98	149.05	26.591	31.258	14.499	172.62	0.6419	4.2488	18.077	12.111	12.313	125.75	0.4715	0.6897	6.9073	26.654	16.183	202.39	0.6766	5.4557	207.55
1940	Chinook_1	0.7321	0.5970	0.4367	131.95	143.65	146.69	21.785	32.737	14.842	194.03	0.6318	4.3715	13.693	13.871	12.922	136.05	0.4609	0.7321	6.4966	28.594	16.257	230.99	0.6625	5.6591	237.77
1941	Chinook_1	0.7351	0.6404	0.4704	132.16	142.62	147.62	22.273	31.224	14.698	161.09	0.6331	4.5034	13.654	13.498	13.127	110.09	0.4930	0.7354	7.0169	25.299	15.807	193.66	0.6344	5.8984	199.64
1942	Chinook_1	0.7021	0.7138	0.5008	132.5	146.63	152.16	27.100	30.298	13.117	202.17	0.6502	4.1093	17.993	11.282	11.401	128.63	0.5002	0.6649	7.4533	26.147	14.277	249.27	0.6737	5.1912	258.36
1943	Chinook_1	0.7232	0.7100	0.5131	131.65	144.02	149.19	22.315	33.236	13.650	247.37	0.6563	4.3741	14.335	14.073	11.862	166.49	0.4882	1.0928	6.3455	30.689	14.853	298.76	0.7022	5.4440	309.38
1944	Chinook_1	0.7084	0.6449	0.4565	132.88	145.97	152.18	26.956	29.373	14.104	141.03	0.6550	4.2117	17.741	10.667	12.316	93.70	0.5305	0.7627	7.6009	23.316	15.377	171.49	0.6556	5.3161	177.65
1945	Chinook_1	0.7094	0.6680	0.4735	132.64	145.33	150.51	25.585	31.802	14.070	204.22	0.6547	4.2291	17.190	11.656	12.231	125.02	0.5060	0.7222	6.7807	28.579	15.336	254.72	0.6787	5.3746	265.76
1946	Chinook_1	0.7230	0.7146	0.5162	131.46	142.03	145.94	20.914	34.782	13.601	282.23	0.6712	4.7847	13.537	14.954	11.817	206.70	0.5061	1.1664	5.7391	33.900	14.801	331.46	0.7283	6.0741	341.02
1947	Chinook_1	0.7370	0.6363	0.4686	131.41	141.68	144.37	19.312	35.469	14.724	258.84	0.6589	4.9690	12.148	15.624	12.894	176.18	0.4949	0.9398	5.5588	34.215	16.052	312.37	0.7041	6.5554	320.89
1948	Chinook_1	0.7208	0.7463	0.5376	131.98	143.64	147.18	21.019	36.342	13.514	388.75	0.7080	4.3292	14.373	14.408	11.710	236.72	0.5314	0.6646	5.0095	38.237	14.738	483.86	0.7932	5.6473	504.82
1949	Chinook_1	0.7312	0.7025	0.5133	131.52	142.04	145.12	20.024	34.958	13.819	285.93	0.6823	4.3262	12.973	14.802	12.157	186.96	0.5100	0.8001	5.4151	34.411	14.977	347.77	0.7488	5.5685	362.28
1950	Chinook_1	0.7110	0.7241	0.5144	132.24	145.06	150.39	24.063	33.134	13.464	272.53	0.6667	4.9524	16.053	12.977	11.650	171.58	0.4921	0.6836	6.3723	31.441	14.695	334.96	0.7277	6.5691	352.69
1951	Chinook_1	0.7357	0.7143	0.5251	131.34	141.14	145.17	19.137	34.929	13.760	273.90	0.6659	4.7806	11.732	16.243	12.136	196.81	0.4958	0.8681	5.7645	33.259	14.855	323.14	0.7229	6.1894	334.14
1952	Chinook_1	0.7193	0.7255	0.5215	131.66	143.4	146.84	21.969	34.264	13.259	278.86	0.6925	4.4670	14.742	13.831	11.569	181.41	0.5291	1.3479	5.5700	34.041	14.412	341.64	0.7564	5.4728	351.68
1953	Chinook_1	0.7228	0.7373	0.5326	132.03	142.83	149.98	22.523	32.587	13.213	251.03	0.6624	4.1876	14.429	13.042	11.787	160.85	0.4928	0.5348	6.4325	30.596	14.163	308.79	0.7138	5.4444	322.20
1954	Chinook_1	0.7096	0.7412	0.5256	132.2	144.04	148.54	23.875	33.025	12.941	274.78	0.6716	4.4349	15.881	13.052	11.270	187.94	0.5031	0.7095	6.3306	31.757	14.073	329.89	0.7312	5.6335	343.58
1955	Chinook_1	0.7008	0.7287	0.5103	132.83	145.42	152.27	26.621	31.204	13.119	234.82	0.6593	4.5861	17.999	11.327	11.465	146.32	0.5126	0.6513	6.9708	28.333	14.240	290.21	0.6868	5.8511	305.59
1956	Chinook_1	0.7226	0.7483	0.5403	131.5	142.85	146.25	19.871	35.931	13.123	352.03	0.7006	4.6817	13.058	15.563	11.447	234.82	0.5306	1.3394	5.1461	37.000	14.243	426.14	0.7810	5.7935	443.22
1957	Chinook_1	0.7191	0.7393	0.5312	131.55	142.5	145.43	20.919	35.411	13.027	338.64	0.7100	4.3399	14.131	14.200	11.488	211.76	0.5373	0.8511	5.1161	36.971	14.070	419.71	0.7957	5.5527	435.11
1958	Chinook_1	0.7137	0.7131	0.5085	132.26	144.51	147.45	22.984	34.471	13.534	298.65	0.6874	4.6097	15.689	13.096	11.803	181.80	0.5199	0.7158	5.6551	34.741	14.731	372.88	0.7517	6.0480	388.92
1959	Chinook_1	0.7321	0.7194	0.5263	131.42	141.98	148.05	20.095	34.170	13.752	267.88	0.6531	5.4398	12.359	15.257	12.084	193.18	0.4774	0.6962	6.1008	32.060	14.876	315.82	0.7088	7.3688	326.42
1960	Chinook_1	0.7146	0.7116	0.5081	131.85	143.66	149.59	24.170	32.004	13.223	232.33	0.6389	4.2260	15.489	13.413	11.419	166.69	0.4567	0.6480	7.0333	28.488	14.437	273.18	0.6893	5.4151	283.90
1961	Chinook_1	0.7333	0.7255	0.5316	131.39	142.15	147.61	20.119	34.023	13.435	287.06	0.6673	4.3018	12.349	15.457	11.908	206.69	0.4881	0.7167	6.1180	31.969	14.460	337.98	0.7319	5.5682	347.86
1962	Chinook_1	0.7192	0.6947	0.4993	131.97	144.08	149.15	23.347	32.887	13.809	233.14	0.6383	4.5926	15.098	13.478	11.956	160.51	0.4597	0.6547	6.6270	30.003	15.058	281.31	0.6825	6.0798	286.57
1963	Chinook_1	0.7263	0.6907	0.5013	132.06	144.22	149.37	22.764	32.326	13.973	211.57	0.6559	4.2709	14.468	13.059	12.316	131.09	0.5008	0.7387	6.6707	29.015	15.098	263.89	0.6877	5.4436	271.08
1964	Chinook_1	0.7071	0.7185	0.5077	132.57	145.1	150.64	24.785	33.288	13.722	276.90	0.6780	4.5246	16.911	12.433	11.834	171.66	0.5160	0.6153	6.2527	31.855	15.016	343.81	0.7318	5.9454	356.96
1965	Chinook_1	0.7269	0.7298	0.5301	131.67	142.66	148.33	21.198	33.948	13.359	267.22	0.6612	4.3691	13.673	13.901	11.742	171.54	0.4938	0.8140	5.8720	33.081	14.464	330.31	0.7125	5.5733	336.00
1966	Chinook_1	0.7181	0.5942	0.4263	132.2	145.17	148.43	24.025	32.026	14.695	195.84	0.6293	4.2506	15.597	13.101	12.575	145.85	0.4572	0.6745	6.8338	27.425	16.247	228.95	0.6607	5.5049	234.63

Columbia River System Operations Environmental Impact Statement
Appendix E: Fish, Aquatic Macroinvertebrates, and Aquatic Habitat

Year	Species	InRivSurvUC	InRivSurvLCol	InRivSurv	MedDayRIS	MedDayConfl	MedDayBON	Mean Travel Time	Mean MigRate	Mean Temp	Mean Flow	Mean FSpill	Mean Gas	UC Travel Time	UCMig Rate	UCTemp	UCFlow	UCFSpill	UCGas	LCTravelTime	LCMigRate	LCTemp	LCFlow	LCFSpill	LCGas	BonFlow
1967	Chinook_1	0.6988	0.7233	0.5051	132.37	146.58	151.36	25.914	32.969	13.301	287.90	0.6808	4.2412	17.786	12.562	11.446	185.19	0.5127	0.5702	6.4846	31.517	14.548	353.92	0.7423	5.4487	364.92
1968	Chinook_1	0.7267	0.6760	0.4909	132.37	143.3	148.54	22.552	32.091	14.518	203.00	0.6598	4.7419	14.359	13.252	12.943	135.25	0.5130	0.7656	6.5868	27.765	15.627	244.13	0.6888	6.1860	256.58
1969	Chinook_1	0.7323	0.7154	0.5235	131.36	141.57	145.12	19.261	35.663	13.797	297.88	0.6814	4.3622	12.330	15.681	12.138	204.22	0.5038	0.7787	5.2949	35.466	14.933	358.92	0.7559	5.6369	364.40
1970	Chinook_1	0.6998	0.7128	0.4984	132.82	146.36	151.09	26.779	31.547	13.106	239.71	0.6774	4.2048	18.302	11.044	11.525	133.74	0.5389	0.7078	6.8165	29.640	14.172	307.34	0.7087	5.3282	316.92
1971	Chinook_1	0.7207	0.7494	0.5397	131.38	142.06	146.72	20.047	36.036	13.135	337.60	0.6985	4.3953	13.353	14.992	11.483	223.40	0.5278	0.9529	5.0306	37.666	14.252	413.19	0.7805	5.5765	419.66
1972	Chinook_1	0.7364	0.7454	0.5485	131.29	140.88	144.75	17.981	36.906	13.601	358.93	0.7013	4.4830	11.280	17.368	12.014	249.97	0.5328	0.7587	5.0541	37.437	14.656	432.21	0.7796	5.8343	433.35
1973	Chinook_1	0.7179	0.6701	0.4807	132.46	144.21	150	25.041	29.890	13.693	169.09	0.6409	4.3596	15.931	11.771	12.102	115.98	0.5046	0.7317	7.4697	24.383	14.805	203.53	0.6439	5.5679	209.42
1974	Chinook_1	0.7340	0.7472	0.5480	131.27	140.48	146.18	17.890	36.891	13.571	343.84	0.7010	4.6539	11.326	16.781	11.911	237.17	0.5349	1.4306	4.9162	37.914	14.680	415.02	0.7792	5.7188	420.27
1975	Chinook_1	0.7097	0.7410	0.5255	132.3	143.85	150.26	24.231	32.896	13.038	270.25	0.6688	5.0658	16.243	12.630	11.366	169.15	0.4979	0.6864	6.3326	31.580	14.158	335.31	0.7264	6.6109	345.68
1976	Chinook_1	0.7136	0.7511	0.5356	131.71	143.28	147.2	22.711	33.839	12.799	286.31	0.6833	4.3001	15.306	13.558	11.162	188.47	0.5103	0.5914	5.7305	33.621	13.902	353.01	0.7536	5.6232	355.45
1977	Chinook_1	0.7246	0.6343	0.4593	132.39	143.24	148.93	24.642	29.272	14.309	125.52	0.6649	4.4666	15.351	11.972	12.744	96.81	0.5247	0.8531	7.6734	22.102	15.451	143.60	0.6850	5.6995	149.47
1978	Chinook_1	0.7224	0.7020	0.5067	131.58	143.75	148.69	22.788	32.249	13.497	227.30	0.6417	4.3349	14.363	13.859	11.783	161.68	0.4685	0.5545	6.7802	28.675	14.639	268.68	0.6846	5.5944	277.42
1979	Chinook_1	0.7125	0.6846	0.4874	132.24	144.93	149.08	25.288	30.809	13.286	202.85	0.6454	4.1898	16.449	12.072	11.619	134.12	0.4898	0.6924	7.1845	26.819	14.434	247.76	0.6692	5.3501	254.60
1980	Chinook_1	0.7233	0.7289	0.5268	131.59	141.42	146.37	21.059	34.004	13.334	273.06	0.6742	4.4591	13.633	13.915	11.665	193.33	0.5154	0.9325	5.7742	33.195	14.472	328.22	0.7256	5.6614	333.10
1981	Chinook_1	0.7320	0.6909	0.5054	132.12	142.49	147.55	21.233	33.354	14.430	228.58	0.6544	4.2040	13.415	13.994	12.882	150.55	0.4935	0.5507	6.2072	30.448	15.524	278.74	0.6923	5.4796	287.49
1982	Chinook_1	0.7273	0.7310	0.5312	131.78	142.69	147	20.713	34.986	13.685	289.95	0.6793	4.6226	13.594	14.246	12.039	183.05	0.5070	0.6380	5.4821	34.981	14.816	361.62	0.7449	6.0541	366.65
1983	Chinook_1	0.7305	0.7289	0.5321	131.66	143.06	148.93	21.490	32.978	13.389	247.00	0.6580	4.6291	13.512	13.762	11.871	149.71	0.4885	0.5725	6.3237	30.807	14.399	309.22	0.7060	6.2695	317.78
1984	Chinook_1	0.7071	0.7111	0.5025	132.5	145.95	151.05	25.301	33.030	13.707	242.59	0.6719	4.2262	17.429	11.792	11.816	127.39	0.5352	0.5742	6.2480	31.801	15.009	317.81	0.6991	5.3955	324.60
1985	Chinook_1	0.7107	0.6718	0.4771	132.31	145.64	149.76	25.278	31.434	13.709	206.96	0.6410	4.3752	16.643	12.372	11.900	139.17	0.4789	0.6653	7.0038	27.523	14.963	249.67	0.6703	5.6011	258.33
1986	Chinook_1	0.7305	0.6886	0.5026	131.67	143.82	149.37	21.723	32.931	14.027	228.09	0.6574	4.3102	13.681	13.944	12.387	140.66	0.4894	0.7406	6.4162	29.808	15.133	283.71	0.7038	5.5452	288.83
1987	Chinook_1	0.7414	0.5869	0.4348	131.49	140.7	142.89	19.292	34.017	15.258	206.85	0.6393	4.3083	11.665	15.790	13.492	166.78	0.4668	0.7809	6.0382	30.017	16.598	234.44	0.6786	5.6332	237.30
1988	Chinook_1	0.7098	0.6564	0.4656	132.39	146.13	151.7	26.653	29.657	13.754	161.03	0.6297	4.1793	17.101	11.816	11.956	116.31	0.4761	0.6308	7.9225	23.485	14.973	190.55	0.6423	5.3309	195.12
1989	Chinook_1	0.7206	0.6738	0.4852	131.77	143.2	147.76	23.198	32.274	13.807	214.58	0.6319	4.4250	14.865	13.509	11.965	158.85	0.4562	0.6629	6.7060	28.552	15.076	252.19	0.6695	5.8975	254.73
1990	Chinook_1	0.7404	0.6044	0.4472	131.56	142.05	145.88	19.862	33.804	15.304	212.03	0.6289	4.5893	12.126	15.462	13.397	158.59	0.4563	0.6464	6.1570	29.461	16.710	247.27	0.6633	6.2401	250.75
1991	Chinook_1	0.7333	0.7109	0.5209	131.43	142.26	147.09	20.564	33.451	13.751	246.81	0.6476	4.1593	12.473	15.173	12.160	180.74	0.4711	0.6099	6.4540	30.379	14.816	291.07	0.6988	5.4728	291.49
1992	Chinook_1	0.7409	0.5749	0.4256	131.68	142.23	145.24	20.655	32.637	15.326	173.35	0.6206	4.2681	12.527	14.862	13.515	133.41	0.4583	0.6875	6.5455	27.151	16.682	200.42	0.6359	5.6074	202.77
1993	Chinook_1	0.6944	0.6789	0.4710	133.14	146.44	149.99	27.353	31.692	13.462	227.66	0.6684	4.1410	19.115	11.118	11.660	138.13	0.5331	0.6677	6.5951	29.503	14.727	287.42	0.6882	5.2957	293.21
1994	Chinook_1	0.7302	0.5717	0.4171	131.89	143.48	146.32	22.377	31.949	14.944	171.04	0.6322	4.2427	14.092	13.488	12.921	129.47	0.4659	0.6324	6.6957	26.784	16.480	197.62	0.6578	5.5665	202.55
1995	Chinook_1	0.7247	0.7129	0.5163	132.14	143.35	149.35	22.769	32.377	13.528	226.07	0.6533	5.3063	14.509	13.057	11.967	141.31	0.4929	0.8771	6.6142	29.692	14.587	280.47	0.6891	6.9494	290.22
1996	Chinook_1	0.7338	0.7279	0.5337	131.46	141.62	146.02	19.371	34.928	13.717	279.72	0.6686	4.5511	12.108	15.587	12.134	192.61	0.5080	1.0368	5.6201	33.878	14.834	336.47	0.7203	5.8211	344.27
1997	Chinook_1	0.7371	0.7530	0.5546	131.31	140.36	143.64	16.947	38.532	13.599	392.24	0.7274	5.2612	10.951	17.359	11.982	271.41	0.5651	1.5776	4.3467	41.560	14.683	473.98	0.8138	6.4135	477.94
1998	Chinook_1	0.7331	0.7156	0.5242	131.5	141.84	146.9	20.016	34.934	13.866	275.34	0.6704	4.4091	12.757	14.667	12.247	174.87	0.5069	0.9011	5.6252	34.424	14.958	341.68	0.7208	5.5932	349.81
1999	Chinook_1	0.7357	0.7212	0.5302	131.52	142.63	148.33	20.157	33.937	13.755	259.59	0.6610	4.7471	12.448	14.938	12.170	166.61	0.4841	0.6291	6.0714	31.828	14.804	319.91	0.7189	6.4858	329.46
2000	Chinook_1	0.7314	0.6152	0.4496	131.62	143.4	146.75	21.148	33.289	14.630	211.84	0.6317	4.2976	13.248	14.602	12.620	155.96	0.4572	0.6881	6.2987	29.506	16.092	247.45	0.6688	5.6060	254.81

Columbia River System Operations Environmental Impact Statement
Appendix E: Fish, Aquatic Macroinvertebrates, and Aquatic Habitat

Year	Species	InRivSurvUC	InRivSurvLCol	InRivSurv	MedDayRIS	MedDayConfl	MedDayBON	Mean Travel Time	Mean MigRate	Mean Temp	Mean Flow	Mean FSpill	Mean Gas	UC Travel Time	UCMig Rate	UCTemp	UCFlow	UCFSpill	UCGas	LCTravelTime	LCMigrate	LCTemp	LCFlow	LCFSpill	LCGas	BonFlow
2001	Chinook_1	0.7191	0.6362	0.4571	132.54	145.19	150.74	25.393	29.481	14.228	135.95	0.6610	4.1868	16.162	11.430	12.549	93.28	0.5344	0.7521	7.6153	23.004	15.406	163.22	0.6661	5.3129	169.75
2002	Chinook_1	0.7187	0.7039	0.5055	131.76	143.96	149.05	22.804	33.171	13.756	253.41	0.6535	4.1427	14.743	13.968	11.888	180.50	0.4747	0.5959	6.4381	30.334	15.011	299.48	0.7106	5.4153	309.77
2003	Chinook_1	0.7289	0.6972	0.5078	131.65	143.45	149.36	21.963	32.127	13.565	228.47	0.6506	4.3075	13.654	13.627	11.987	148.67	0.4783	0.7235	6.6618	28.617	14.642	276.17	0.6966	5.5359	294.05
2004	Chinook_1	0.7290	0.6685	0.4870	131.73	143.75	149.48	22.945	31.233	13.998	189.43	0.6263	4.5004	14.177	13.293	12.310	125.77	0.4681	0.6703	7.1429	26.077	15.146	225.79	0.6424	5.9857	245.61
2005	Chinook_1	0.7345	0.6519	0.4785	132.17	142.25	146.19	21.772	32.110	14.647	186.51	0.6352	4.2240	13.559	13.721	13.047	123.85	0.4853	0.7270	6.6104	27.346	15.781	227.43	0.6477	5.3955	232.79
2006	Chinook_1	0.7178	0.7190	0.5158	131.72	144.16	146.98	21.986	34.620	13.453	295.75	0.6852	4.3393	14.805	14.043	11.755	192.62	0.5169	0.6588	5.5336	34.513	14.614	363.28	0.7524	5.6170	371.52
2007	Chinook_1	0.7389	0.6765	0.4995	131.44	140.89	145.03	19.985	33.324	14.447	218.06	0.6395	4.2266	12.003	15.685	12.875	167.62	0.4685	0.7013	6.3683	29.015	15.538	251.10	0.6789	5.4708	256.72
2008	Chinook_1	0.7040	0.7149	0.5029	132.83	145.51	149.19	24.888	33.740	13.860	280.36	0.7032	4.1332	17.453	11.922	12.050	155.60	0.5591	0.6050	5.8145	33.381	15.092	358.70	0.7570	5.3366	377.42
MO3																										
1929	Chinook_1	0.6892	0.6701	0.4615	133.42	148.37	152.04	28.417	30.631	13.886	155.60	0.7801	3.0718	20.595	9.712	12.026	93.49	0.6250	0.8898	6.1999	27.497	15.224	194.60	0.8888	2.4274	203.64
1930	Chinook_1	0.7256	0.5893	0.4273	132.35	145.28	147.39	22.649	32.099	15.113	134.47	0.7851	3.1143	15.252	12.163	13.185	94.59	0.6127	0.8849	5.8100	28.200	16.563	160.33	0.9125	2.5870	165.20
1931	Chinook_1	0.7256	0.5734	0.4158	132.39	145.01	146.53	22.729	32.000	15.118	131.98	0.7840	2.9656	15.296	12.168	13.226	93.89	0.6130	0.6179	5.8420	28.021	16.578	155.65	0.9089	2.5668	162.15
1932	Chinook_1	0.7201	0.7344	0.5285	131.74	143.15	146.69	21.630	34.010	13.193	255.59	0.7176	3.0862	14.586	13.944	11.556	172.13	0.5189	0.7117	5.3804	33.467	14.294	310.00	0.8333	2.7201	318.64
1933	Chinook_1	0.7282	0.7328	0.5332	131.76	143.42	148.71	20.701	34.149	13.806	248.44	0.7389	3.8934	13.786	13.704	12.179	160.97	0.5449	1.0425	5.2786	33.330	14.927	304.01	0.8622	3.6914	316.32
1934	Chinook_1	0.7459	0.6312	0.4705	131.3	139.8	141.16	16.126	36.852	15.054	250.96	0.7327	3.2609	9.664	18.818	13.351	212.86	0.5389	1.2175	4.8500	35.192	16.354	275.16	0.8590	2.9086	281.40
1935	Chinook_1	0.7230	0.7097	0.5128	132.23	143.85	148.14	22.042	32.960	13.847	203.43	0.7454	2.8423	14.836	12.942	12.168	143.18	0.5462	0.6503	5.5746	30.872	15.022	241.43	0.8755	2.2280	250.70
1936	Chinook_1	0.7155	0.6381	0.4562	132.23	144.71	145.94	22.406	34.565	14.262	238.41	0.7276	2.9358	15.747	13.083	12.355	157.92	0.5282	0.5909	5.0326	34.621	15.732	289.68	0.8482	2.5494	299.59
1937	Chinook_1	0.7021	0.6926	0.4859	132.87	146.13	150.29	26.298	30.819	13.544	160.92	0.7751	2.9604	18.445	10.791	11.847	104.31	0.6030	0.6164	6.2112	27.568	14.721	196.71	0.8961	2.4424	206.58
1938	Chinook_1	0.7251	0.7230	0.5239	131.73	143.54	147.25	20.975	34.242	13.653	243.19	0.7251	2.9800	14.034	14.086	11.972	160.82	0.5284	0.7036	5.2980	33.428	14.801	295.63	0.8426	2.5330	305.00
1939	Chinook_1	0.7018	0.5838	0.4094	132.49	147.3	147.81	25.627	32.344	14.382	168.97	0.7640	2.9101	18.406	11.944	12.353	120.76	0.5682	0.5970	5.5976	29.946	16.009	199.11	0.9007	2.3946	205.42
1940	Chinook_1	0.7322	0.6224	0.4553	131.87	143.7	145.37	20.595	33.935	14.768	189.99	0.7547	3.1626	13.715	13.800	12.949	132.98	0.5526	0.8608	5.2733	31.951	16.139	226.16	0.8932	2.6610	233.27
1941	Chinook_1	0.7355	0.6702	0.4926	132.16	142.68	146.55	20.935	32.732	14.664	158.14	0.7741	3.2839	13.617	13.497	13.141	108.28	0.5905	0.8711	5.7087	29.253	15.756	189.91	0.9054	2.8617	195.85
1942	Chinook_1	0.6983	0.7394	0.5159	132.61	146.96	151.39	26.334	31.247	12.956	197.55	0.7516	2.8239	18.624	10.940	11.320	124.13	0.5736	0.6335	6.0445	29.113	14.068	244.72	0.8652	2.1629	253.28
1943	Chinook_1	0.7228	0.7329	0.5294	131.6	143.93	148.08	21.255	34.147	13.563	246.23	0.7241	3.0231	14.251	14.097	11.865	166.85	0.5250	0.7332	5.3591	33.197	14.713	296.80	0.8444	2.5957	306.91
1944	Chinook_1	0.7079	0.6697	0.4737	132.89	146.26	151.13	25.857	30.480	14.040	132.76	0.7888	3.0964	17.899	10.503	12.331	87.27	0.6299	0.8880	6.3382	26.381	15.261	161.84	0.9066	2.4505	167.78
1945	Chinook_1	0.7092	0.6902	0.4891	132.64	145.61	149.23	24.485	32.719	14.007	196.83	0.7569	3.0913	17.304	11.568	12.253	118.26	0.5831	0.8400	5.5578	31.178	15.236	246.40	0.8692	2.4936	257.45
1946	Chinook_1	0.7218	0.7309	0.5272	131.47	142.08	145.53	20.379	35.248	13.548	279.95	0.7125	3.2840	13.605	14.848	11.829	205.20	0.5241	0.8253	5.1298	35.318	14.709	328.72	0.8189	2.8562	338.23
1947	Chinook_1	0.7360	0.6530	0.4802	131.43	141.81	143.71	18.730	36.042	14.697	252.86	0.7214	3.3337	12.263	15.450	12.925	172.27	0.5262	0.7032	4.8539	35.988	16.007	305.00	0.8360	2.9457	313.11
1948	Chinook_1	0.7187	0.7563	0.5432	131.97	143.65	147.17	20.591	37.708	13.478	385.70	0.7321	3.1285	14.479	14.307	11.727	235.69	0.5504	0.7670	4.4674	41.922	14.678	480.29	0.8415	2.6877	500.05
1949	Chinook_1	0.7301	0.7161	0.5224	131.53	142.2	145.56	19.756	35.444	13.776	278.25	0.7161	3.0742	13.082	14.638	12.172	182.28	0.5316	0.8488	5.0335	35.904	14.889	338.83	0.8184	2.5520	352.38
1950	Chinook_1	0.7100	0.7422	0.5266	132.25	145.14	149.41	23.169	33.928	13.369	267.78	0.7291	3.6263	16.192	12.899	11.633	171.99	0.5391	0.8385	5.3291	33.758	14.556	327.61	0.8445	3.3238	343.35
1951	Chinook_1	0.7349	0.7319	0.5375	131.34	141.14	145.12	18.537	35.499	13.709	270.53	0.7180	3.1966	11.757	16.151	12.141	195.42	0.5280	0.7532	5.1326	34.936	14.767	318.85	0.8283	2.6704	329.19
1952	Chinook_1	0.7163	0.7368	0.5274	131.67	143.5	147.02	21.781	34.641	13.195	277.22	0.7100	2.9417	14.897	13.717	11.552	180.76	0.5235	0.6774	5.2211	35.216	14.314	339.61	0.8115	2.5300	349.23
1953	Chinook_1	0.7221	0.7557	0.5453	132.09	142.93	148.56	21.752	33.319	13.160	245.02	0.7368	3.0144	14.596	12.872	11.806	157.12	0.5530	0.6320	5.4884	32.739	14.064	301.29	0.8492	2.5416	314.08

Columbia River System Operations Environmental Impact Statement
Appendix E: Fish, Aquatic Macroinvertebrates, and Aquatic Habitat

Year	Species	InRivSurvUC	InRivSurvLCol	InRivSurv	MedDayRIS	MedDayConfl	MedDayBON	Mean Travel Time	Mean MigRate	Mean Temp	Mean Flow	Mean FSpill	Mean Gas	UC Travel Time	UCMig Rate	UCTemp	UCFlow	UCFSpill	UCGas	LCTravelTime	LCMigRate	LCTemp	LCFlow	LCFSpill	LCGas	BonFlow
1954	Chinook_1	0.7067	0.7602	0.5368	132.25	144.24	148.65	23.433	33.452	12.801	269.89	0.7220	3.3940	16.269	12.777	11.187	186.68	0.5413	0.8576	5.4901	33.301	13.890	323.49	0.8258	2.9253	335.46
1955	Chinook_1	0.7006	0.7523	0.5267	132.85	145.5	150.85	25.436	32.206	13.019	228.48	0.7512	3.4215	18.054	11.284	11.478	145.18	0.5762	0.7890	5.7207	31.127	14.067	281.08	0.8633	2.9072	294.74
1956	Chinook_1	0.7212	0.7580	0.5463	131.51	142.88	146.49	19.718	36.683	13.048	349.45	0.7166	3.3109	13.164	15.510	11.426	234.99	0.5468	1.2354	4.8832	39.042	14.127	422.82	0.8091	2.7347	438.38
1957	Chinook_1	0.7168	0.7456	0.5341	131.66	142.68	145.86	21.132	35.881	12.943	333.37	0.7148	3.1120	14.439	13.948	11.411	207.91	0.5525	0.8662	5.0147	38.502	13.984	413.68	0.7964	2.5671	428.45
1958	Chinook_1	0.7113	0.7265	0.5164	132.28	144.75	148	22.735	35.039	13.456	292.16	0.7158	3.2578	15.985	12.895	11.795	177.58	0.5380	0.6284	5.1024	36.532	14.606	365.41	0.8110	2.9925	380.32
1959	Chinook_1	0.7320	0.7366	0.5388	131.43	142	146.66	19.242	34.980	13.716	263.42	0.7259	4.2461	12.427	15.136	12.094	190.84	0.5308	0.8905	5.1724	34.370	14.820	310.06	0.8461	4.4346	320.25
1960	Chinook_1	0.7122	0.7365	0.5242	131.99	143.72	148.24	23.143	32.855	13.104	229.90	0.7304	3.0086	15.802	13.174	11.378	165.31	0.5274	0.6668	5.6823	31.116	14.275	270.23	0.8590	2.5522	280.20
1961	Chinook_1	0.7325	0.7428	0.5437	131.4	142.1	146.84	19.359	34.892	13.344	282.67	0.7286	3.0925	12.423	15.330	11.855	205.26	0.5424	0.7139	5.2746	34.466	14.341	331.96	0.8403	2.7689	340.74
1962	Chinook_1	0.7190	0.7222	0.5189	131.97	144.15	148.12	22.209	33.793	13.702	229.89	0.7297	3.2118	15.154	13.383	11.968	158.64	0.5274	0.6808	5.4208	32.660	14.881	277.22	0.8541	2.8826	282.12
1963	Chinook_1	0.7248	0.7130	0.5164	132.12	144.47	148.59	21.849	33.220	13.939	207.05	0.7485	2.9792	14.701	12.798	12.337	127.84	0.5702	0.7009	5.5165	31.632	15.034	258.50	0.8605	2.4625	265.50
1964	Chinook_1	0.7039	0.7344	0.5166	132.8	145.39	149.76	24.286	33.984	13.681	268.12	0.7398	3.2697	17.386	12.052	11.872	166.84	0.5687	0.7552	5.2700	34.106	14.935	333.22	0.8425	2.7522	344.31
1965	Chinook_1	0.7260	0.7460	0.5412	131.68	142.68	147.34	20.636	34.576	13.274	264.13	0.7147	3.1141	13.778	13.759	11.684	169.45	0.5204	0.7045	5.1979	34.948	14.362	326.81	0.8249	2.7452	332.12
1966	Chinook_1	0.7161	0.6214	0.4447	132.26	145.45	147.35	23.070	33.147	14.584	192.12	0.7493	2.9479	15.953	12.854	12.584	143.00	0.5436	0.6485	5.5088	30.787	16.091	224.27	0.8880	2.4596	230.49
1967	Chinook_1	0.6982	0.7376	0.5146	132.36	146.63	150.48	24.894	33.806	13.223	285.43	0.7304	3.0587	17.803	12.611	11.450	188.10	0.5524	0.6938	5.4376	33.831	14.428	348.75	0.8338	2.4857	357.73
1968	Chinook_1	0.7264	0.6961	0.5053	132.41	143.4	147.59	21.567	33.167	14.536	197.20	0.7544	3.3189	14.430	13.148	12.969	133.45	0.5790	0.6862	5.5278	30.625	15.662	236.31	0.8701	2.9517	247.39
1969	Chinook_1	0.7315	0.7270	0.5314	131.34	141.48	145.17	18.901	36.258	13.742	297.57	0.7090	3.0784	12.301	15.670	12.144	205.28	0.5271	0.7366	4.9567	37.140	14.833	358.21	0.8076	2.6977	362.88
1970	Chinook_1	0.6961	0.7313	0.5087	133.04	146.78	150.95	26.329	32.058	12.995	230.86	0.7411	2.9329	18.856	10.774	11.526	129.41	0.5802	0.5949	5.8025	31.388	13.992	296.51	0.8336	2.4166	304.08
1971	Chinook_1	0.7192	0.7531	0.5413	131.38	142.16	146.16	20.146	36.531	13.131	334.54	0.7029	3.2516	13.505	14.844	11.466	222.48	0.5365	1.0357	4.9756	39.072	14.262	409.52	0.7857	2.7713	414.97
1972	Chinook_1	0.7365	0.7543	0.5551	131.3	140.91	144.84	17.663	37.899	13.566	354.91	0.7233	3.3720	11.326	17.308	12.029	246.98	0.5569	0.9662	4.6823	40.162	14.589	428.37	0.8144	3.1004	428.19
1973	Chinook_1	0.7165	0.6943	0.4971	132.49	144.32	148.64	23.961	31.059	13.585	164.94	0.7694	3.2289	16.159	11.567	12.049	112.54	0.5926	0.8719	6.1548	27.678	14.669	198.68	0.8915	2.6795	204.93
1974	Chinook_1	0.7331	0.7526	0.5513	131.26	140.5	145.12	17.730	37.610	13.588	340.81	0.7142	3.4907	11.389	16.649	11.926	234.74	0.5427	1.5506	4.6918	39.839	14.709	412.55	0.8078	2.9150	416.40
1975	Chinook_1	0.7079	0.7582	0.5363	132.34	144.02	149.08	23.620	33.491	12.956	262.43	0.7263	3.8817	16.492	12.428	11.390	165.75	0.5428	0.8242	5.4619	33.483	14.012	325.36	0.8332	3.7178	333.71
1976	Chinook_1	0.7106	0.7625	0.5415	131.75	143.42	147.62	22.605	34.215	12.697	283.24	0.7085	3.2861	15.607	13.333	11.082	187.87	0.5253	0.7088	5.3170	34.941	13.786	348.79	0.8064	2.9846	350.30
1977	Chinook_1	0.7231	0.6531	0.4719	132.43	143.41	148	23.747	30.333	14.257	120.88	0.7797	3.3703	15.621	11.715	12.713	92.23	0.6114	1.1006	6.5016	25.132	15.409	138.73	0.8993	2.7962	144.86
1978	Chinook_1	0.7216	0.7232	0.5215	131.59	143.92	147.75	21.764	33.167	13.414	224.40	0.7348	3.1372	14.539	13.737	11.772	159.70	0.5322	0.6702	5.5693	31.344	14.520	265.17	0.8641	2.6881	273.72
1979	Chinook_1	0.7088	0.7085	0.5018	132.31	145.17	148.48	24.487	31.785	13.134	200.36	0.7504	2.9982	16.979	11.710	11.551	130.86	0.5633	0.8080	5.8403	29.871	14.239	245.45	0.8709	2.3353	253.21
1980	Chinook_1	0.7217	0.7425	0.5354	131.61	141.47	145.8	20.704	34.427	13.264	267.58	0.7220	3.1864	13.842	13.614	11.621	189.30	0.5422	0.8423	5.2042	34.648	14.394	321.77	0.8233	2.7691	326.66
1981	Chinook_1	0.7313	0.7115	0.5200	132.19	142.54	146.59	20.338	34.458	14.446	225.56	0.7401	3.1093	13.536	13.860	12.911	148.70	0.5559	0.6786	5.1863	33.421	15.549	275.19	0.8541	2.7278	283.37
1982	Chinook_1	0.7259	0.7421	0.5383	131.82	142.81	147.14	20.350	35.749	13.674	288.28	0.7196	3.3196	13.757	14.096	12.057	181.69	0.5414	0.7957	4.9522	37.122	14.788	360.09	0.8178	2.8696	364.67
1983	Chinook_1	0.7289	0.7479	0.5447	131.69	143.15	148.07	20.808	33.743	13.294	242.07	0.7296	3.4431	13.717	13.535	11.817	146.69	0.5433	0.7489	5.4280	33.131	14.277	303.63	0.8395	3.3049	310.99
1984	Chinook_1	0.7057	0.7302	0.5149	132.55	146.13	150.12	24.517	33.909	13.654	238.84	0.7385	3.0592	17.656	11.625	11.842	124.57	0.5699	0.6668	5.2279	34.368	14.918	313.77	0.8367	2.5554	319.82
1985	Chinook_1	0.7093	0.7014	0.4972	132.33	145.74	149.04	24.196	32.501	13.572	205.97	0.7450	3.2068	16.869	12.245	11.888	138.18	0.5527	0.7952	5.6823	30.625	14.749	248.95	0.8689	2.6700	257.36
1986	Chinook_1	0.7299	0.7100	0.5179	131.69	143.9	148.17	20.814	33.868	13.952	223.65	0.7410	3.1217	13.776	13.819	12.402	138.88	0.5555	0.7365	5.4027	32.513	15.006	278.24	0.8572	2.8322	282.18
1987	Chinook_1	0.7417	0.6059	0.4491	131.52	140.92	142.16	18.439	35.108	15.287	199.09	0.7505	2.9631	11.779	15.594	13.532	159.75	0.5468	0.7195	5.0668	33.028	16.648	225.79	0.8892	2.5600	229.35

Columbia River System Operations Environmental Impact Statement
Appendix E: Fish, Aquatic Macroinvertebrates, and Aquatic Habitat

Year	Species	InRivSurvUC	InRivSurvLCol	InRivSurv	MedDayRIS	MedDayConfl	MedDayBON	Mean Travel Time	Mean MigRate	Mean Temp	Mean Flow	Mean FSpill	Mean Gas	UC Travel Time	UCMig Rate	UCTemp	UCFlow	UCFSpill	UCGas	LCTravelTime	LCMigRate	LCTemp	LCFlow	LCFSpill	LCGas	BonFlow
1988	Chinook_1	0.7083	0.6890	0.4877	132.39	146.34	150.24	25.271	30.962	13.606	157.87	0.7688	3.0480	17.363	11.686	11.949	113.77	0.5758	0.7799	6.2654	27.210	14.743	186.92	0.9065	2.4709	191.61
1989	Chinook_1	0.7202	0.7005	0.5041	131.8	143.31	146.73	22.163	33.260	13.728	210.41	0.7388	3.1008	14.990	13.362	11.981	155.30	0.5319	0.7682	5.5372	31.378	14.938	247.41	0.8733	2.6311	250.08
1990	Chinook_1	0.7402	0.6279	0.4644	131.58	142.1	144.74	18.805	35.242	15.295	209.92	0.7395	3.3263	12.172	15.378	13.424	157.13	0.5329	0.8071	5.0463	33.351	16.714	244.93	0.8757	3.2047	248.05
1991	Chinook_1	0.7330	0.7311	0.5355	131.43	142.27	146.65	19.591	34.322	13.714	241.84	0.7244	3.0974	12.520	15.073	12.173	178.79	0.5266	0.7879	5.4262	32.826	14.747	284.71	0.8449	2.7882	283.88
1992	Chinook_1	0.7403	0.5999	0.4438	131.76	142.42	144.23	19.605	34.099	15.329	168.65	0.7624	3.0253	12.689	14.666	13.556	129.26	0.5566	0.8114	5.3269	31.156	16.695	194.92	0.9078	2.5440	197.78
1993	Chinook_1	0.6926	0.7007	0.4849	133.18	146.61	149.49	26.594	32.479	13.372	221.31	0.7470	2.8895	19.320	10.968	11.673	133.99	0.5847	0.5399	5.6233	31.813	14.567	279.85	0.8434	2.4163	284.47
1994	Chinook_1	0.7291	0.5939	0.4327	132.12	143.94	145.22	21.508	33.073	14.895	161.52	0.7668	3.1097	14.393	13.177	12.967	120.58	0.5675	0.7896	5.5170	30.090	16.389	187.52	0.9087	2.6966	192.62
1995	Chinook_1	0.7234	0.7351	0.5314	132.18	143.47	148.23	21.921	33.113	13.429	220.77	0.7405	4.0514	14.743	12.805	11.915	137.98	0.5561	1.0446	5.5228	31.949	14.455	274.08	0.8538	3.8700	283.14
1996	Chinook_1	0.7322	0.7411	0.5422	131.51	141.77	145.7	18.957	35.514	13.705	274.83	0.7149	3.2359	12.294	15.335	12.105	188.35	0.5240	0.8893	5.0160	35.636	14.850	331.23	0.8255	2.9191	338.96
1997	Chinook_1	0.7361	0.7573	0.5570	131.32	140.31	143.81	17.015	39.356	13.588	388.99	0.7206	3.9614	10.973	17.281	11.993	269.03	0.5640	1.5485	4.3930	43.702	14.656	470.62	0.8006	3.4230	474.17
1998	Chinook_1	0.7317	0.7287	0.5328	131.51	142.13	146.2	19.599	35.442	13.859	268.36	0.7143	3.0610	12.914	14.465	12.267	169.07	0.5279	0.6436	5.0471	35.971	14.941	333.90	0.8157	2.7231	341.42
1999	Chinook_1	0.7361	0.7371	0.5421	131.49	142.56	147.21	19.100	34.874	13.717	257.14	0.7234	3.7655	12.225	15.104	12.166	168.18	0.5295	1.3038	5.2282	34.246	14.751	315.40	0.8380	3.5337	323.27
2000	Chinook_1	0.7316	0.6394	0.4674	131.64	143.44	145.47	20.116	34.404	14.571	209.43	0.7427	3.1094	13.305	14.495	12.645	153.34	0.5358	0.7184	5.1991	32.650	16.001	244.94	0.8806	2.8574	252.84
2001	Chinook_1	0.7190	0.6628	0.4761	132.53	145.26	149.12	24.107	30.739	14.140	134.52	0.7841	3.0763	16.192	11.369	12.558	91.57	0.6218	0.9068	6.2908	26.419	15.258	161.72	0.9010	2.4546	168.82
2002	Chinook_1	0.7178	0.7264	0.5210	131.77	144.18	148.24	21.951	33.980	13.661	248.20	0.7292	2.9739	14.927	13.792	11.906	176.82	0.5333	0.7106	5.3892	32.799	14.849	293.65	0.8507	2.4952	302.99
2003	Chinook_1	0.7276	0.7176	0.5217	131.72	143.6	148.16	21.170	32.967	13.464	221.96	0.7409	3.1304	13.905	13.368	11.940	144.61	0.5497	0.8586	5.6082	31.172	14.509	268.13	0.8619	2.5997	285.28
2004	Chinook_1	0.7282	0.6989	0.5086	131.77	143.92	148.11	21.720	32.465	13.910	185.78	0.7578	3.1778	14.328	13.111	12.329	121.79	0.5660	0.8022	5.7568	29.568	14.987	222.10	0.8891	2.7089	242.19
2005	Chinook_1	0.7341	0.6798	0.4987	132.2	142.41	145.61	20.702	33.486	14.622	182.65	0.7598	2.9093	13.671	13.584	13.070	120.46	0.5712	0.6236	5.4216	31.057	15.737	223.40	0.8874	2.3932	228.56
2006	Chinook_1	0.7156	0.7314	0.5230	131.81	144.37	147.5	21.806	35.170	13.381	291.95	0.7153	2.9121	15.087	13.871	11.744	190.72	0.5351	0.6174	5.0642	36.216	14.498	359.35	0.8138	2.3377	366.15
2007	Chinook_1	0.7405	0.7012	0.5188	131.51	141.03	144.51	18.818	34.404	14.424	211.82	0.7401	3.0674	11.891	15.668	12.892	163.31	0.5314	0.7176	5.3065	31.917	15.500	243.62	0.8778	2.8095	248.96
2008	Chinook_1	0.7032	0.7262	0.5102	132.83	145.57	149.21	24.356	34.331	13.804	272.30	0.7349	2.9942	17.525	11.856	12.066	154.15	0.5827	0.6848	5.2031	35.114	14.996	347.37	0.8183	2.4777	363.35
MO4																										
1929	Chinook_1	0.7010	0.6843	0.4790	132.91	146.97	150.4	26.245	30.063	13.786	173.11	0.7900	10.9866	18.485	10.722	12.026	113.66	0.5879	1.1657	5.9727	27.832	15.051	211.01	0.9474	16.7271	219.40
1930	Chinook_1	0.7293	0.6079	0.4427	132.31	144	146.04	21.944	31.124	14.964	153.07	0.7834	9.6472	14.445	12.658	13.110	113.81	0.5825	0.6683	5.7473	28.023	16.334	178.85	0.9356	14.8946	183.64
1931	Chinook_1	0.7300	0.5958	0.4343	132.26	143.72	145.26	21.802	31.203	14.964	157.07	0.7796	9.7843	14.322	12.794	13.150	118.22	0.5767	0.7240	5.7257	28.182	16.335	181.42	0.9310	15.0223	188.12
1932	Chinook_1	0.7187	0.7342	0.5269	131.89	143.37	146.74	21.884	32.631	13.280	253.71	0.7657	13.2205	14.828	13.596	11.645	170.11	0.5351	2.0689	5.2403	32.508	14.387	308.20	0.9397	20.1030	316.97
1933	Chinook_1	0.7284	0.7323	0.5327	131.84	143.56	148.8	20.837	32.498	13.859	248.17	0.7656	12.6721	13.751	13.501	12.286	160.83	0.5488	1.9824	5.2942	31.715	14.945	303.52	0.9256	19.0123	315.84
1934	Chinook_1	0.7446	0.6374	0.4739	131.38	139.89	141.35	16.470	35.066	14.974	250.63	0.7721	14.1099	9.812	18.241	13.320	213.39	0.5495	5.5954	4.8854	33.721	16.213	274.41	0.9486	19.0844	280.20
1935	Chinook_1	0.7229	0.7079	0.5110	132.32	143.97	148.16	22.197	31.570	13.916	203.37	0.7772	11.3878	14.848	12.718	12.278	143.05	0.5528	0.8897	5.5633	29.917	15.068	241.50	0.9496	17.6056	250.74
1936	Chinook_1	0.7155	0.6464	0.4618	132.31	144.77	146.08	22.480	33.097	14.264	238.46	0.7701	12.7208	15.713	12.833	12.357	158.24	0.5397	1.3879	4.9860	33.519	15.707	289.75	0.9448	19.6961	299.40
1937	Chinook_1	0.7099	0.6956	0.4930	132.5	144.81	148.73	24.862	30.102	13.565	174.37	0.7863	10.6431	17.039	11.463	11.878	120.13	0.5774	0.8005	6.0248	27.577	14.735	209.20	0.9472	16.3844	218.27
1938	Chinook_1	0.7240	0.7193	0.5200	131.85	143.82	147.49	21.252	32.747	13.713	240.36	0.7681	12.5922	14.249	13.707	12.005	157.53	0.5426	1.3750	5.2055	32.303	14.890	292.84	0.9380	19.4331	302.57
1939	Chinook_1	0.7020	0.6046	0.4238	132.55	147.17	148.28	25.372	31.399	14.372	186.98	0.7769	11.0270	18.083	12.031	12.324	136.35	0.5492	0.9492	5.5137	29.810	15.953	219.60	0.9508	16.9803	225.58
1940	Chinook_1	0.7311	0.6329	0.4620	131.93	143.71	145.64	20.803	32.568	14.756	197.45	0.7776	11.4395	13.761	13.583	12.937	140.07	0.5470	0.8617	5.2804	31.118	16.094	234.41	0.9558	17.7587	241.14

Columbia River System Operations Environmental Impact Statement
Appendix E: Fish, Aquatic Macroinvertebrates, and Aquatic Habitat

Year	Species	InRivSurvUC	InRivSurvLCol	InRivSurv	MedDayRIS	MedDayConfl	MedDayBON	Mean Travel Time	Mean MigRate	Mean Temp	Mean Flow	Mean FSpill	Mean Gas	UC Travel Time	UCMig Rate	UCTemp	UCFlow	UCFSpill	UCGas	LCTravelTime	LCMigRate	LCTemp	LCFlow	LCFSpill	LCGas	BonFlow
1941	Chinook_1	0.7372	0.6770	0.4983	131.88	142.22	145.81	20.442	31.823	14.580	179.03	0.7823	10.7150	13.072	13.832	13.079	127.14	0.5658	0.7831	5.5996	29.252	15.650	212.42	0.9484	16.5568	218.79
1942	Chinook_1	0.7065	0.7432	0.5243	132.46	145.66	149.95	24.813	30.566	12.964	208.26	0.7782	11.7879	17.187	11.568	11.353	138.90	0.5520	0.9428	5.8024	29.209	14.060	252.96	0.9518	18.3472	260.84
1943	Chinook_1	0.7222	0.7318	0.5277	131.68	143.98	148.11	21.340	32.761	13.602	246.69	0.7655	12.6295	14.305	13.832	11.879	167.24	0.5373	1.3022	5.2346	32.271	14.781	297.23	0.9374	19.5737	307.48
1944	Chinook_1	0.7144	0.6784	0.4839	132.57	144.58	148.65	24.379	30.037	13.983	161.21	0.7854	10.2572	16.564	11.230	12.299	115.44	0.5858	1.0311	6.0337	27.206	15.196	191.53	0.9374	15.6056	197.17
1945	Chinook_1	0.7106	0.6909	0.4902	132.69	145.44	149.09	24.331	31.471	14.067	196.65	0.7906	11.9616	17.048	11.628	12.344	119.74	0.5845	1.2812	5.5060	30.375	15.280	245.52	0.9525	18.3165	256.00
1946	Chinook_1	0.7206	0.7300	0.5253	131.58	142.26	145.54	20.574	33.771	13.603	278.83	0.7632	14.4332	13.819	14.415	11.858	203.50	0.5446	4.7991	4.9567	34.278	14.796	327.99	0.9281	20.2920	337.77
1947	Chinook_1	0.7348	0.6608	0.4848	131.53	141.97	143.88	18.982	34.440	14.688	252.83	0.7681	12.9820	12.410	15.024	12.928	172.76	0.5416	1.6860	4.8044	34.748	15.965	304.88	0.9401	19.9509	312.63
1948	Chinook_1	0.7184	0.7552	0.5417	132.02	143.74	147.2	20.776	35.108	13.551	385.37	0.7564	17.2489	14.492	14.074	11.822	236.04	0.5551	5.0793	4.4857	37.905	14.745	479.29	0.8984	24.8836	498.54
1949	Chinook_1	0.7292	0.7181	0.5229	131.62	142.32	145.37	19.875	33.750	13.802	279.37	0.7571	13.5318	13.172	14.310	12.202	182.76	0.5444	2.6547	4.9057	34.295	14.924	340.14	0.9101	20.1937	354.10
1950	Chinook_1	0.7106	0.7414	0.5260	132.33	145.28	149.45	23.221	32.338	13.438	265.94	0.7631	13.1287	16.124	12.693	11.740	170.36	0.5460	1.9059	5.2936	32.249	14.609	325.50	0.9237	19.8569	341.18
1951	Chinook_1	0.7341	0.7315	0.5363	131.43	141.27	144.89	18.633	33.989	13.737	271.40	0.7649	13.6654	11.827	15.789	12.167	195.89	0.5440	3.0915	5.0033	33.794	14.805	319.85	0.9321	20.0805	330.50
1952	Chinook_1	0.7161	0.7380	0.5277	131.75	143.6	146.77	21.723	33.138	13.226	277.43	0.7589	14.0537	14.895	13.457	11.571	180.77	0.5440	3.4706	5.0079	33.969	14.367	339.84	0.9163	20.6854	349.73
1953	Chinook_1	0.7215	0.7556	0.5443	132.22	143.05	148.55	21.836	31.949	13.202	247.19	0.7730	13.0257	14.643	12.650	11.837	159.47	0.5585	2.1417	5.3713	31.728	14.118	303.50	0.9351	19.5759	316.11
1954	Chinook_1	0.7073	0.7603	0.5370	132.32	144.31	148.42	23.301	32.100	12.870	269.82	0.7675	13.9544	16.141	12.646	11.265	186.72	0.5549	3.8329	5.3320	32.241	13.961	323.22	0.9283	20.1248	335.33
1955	Chinook_1	0.7033	0.7512	0.5275	132.68	145.1	150.33	24.927	31.120	13.076	234.00	0.7781	12.4869	17.527	11.432	11.493	151.81	0.5684	1.6231	5.5854	30.511	14.154	286.00	0.9381	19.0051	299.48
1956	Chinook_1	0.7214	0.7592	0.5469	131.6	142.98	146.35	19.728	34.520	13.090	349.45	0.7498	16.0469	13.146	15.175	11.446	234.95	0.5532	5.6916	4.7545	36.171	14.198	422.56	0.8858	22.0273	438.31
1957	Chinook_1	0.7165	0.7525	0.5384	131.7	143	146.15	21.097	33.760	12.998	330.71	0.7515	15.5717	14.437	13.690	11.491	206.65	0.5573	5.2240	4.8272	35.627	14.027	410.38	0.8845	21.6824	424.51
1958	Chinook_1	0.7110	0.7293	0.5177	132.36	144.87	147.74	22.739	33.261	13.487	289.59	0.7579	13.8587	15.988	12.639	11.820	176.15	0.5481	2.3751	4.9471	34.622	14.657	362.15	0.9080	20.8531	376.72
1959	Chinook_1	0.7318	0.7367	0.5383	131.52	142.12	146.71	19.343	33.449	13.761	263.86	0.7644	13.1117	12.424	14.889	12.197	191.18	0.5375	2.1383	5.1203	33.086	14.829	310.39	0.9370	19.6958	320.74
1960	Chinook_1	0.7122	0.7352	0.5229	132.07	143.83	148.39	23.184	31.582	13.182	230.33	0.7684	12.1579	15.782	12.993	11.458	165.35	0.5369	1.2991	5.5894	30.309	14.357	270.77	0.9460	18.6440	281.07
1961	Chinook_1	0.7318	0.7436	0.5433	131.5	142.27	146.79	19.565	33.162	13.414	282.28	0.7611	13.6114	12.539	14.963	11.943	205.13	0.5483	3.4832	5.2111	32.680	14.403	331.35	0.9163	19.5521	339.98
1962	Chinook_1	0.7185	0.7187	0.5156	132.06	144.22	148.11	22.310	32.443	13.754	230.00	0.7700	12.2978	15.194	13.149	11.984	158.89	0.5357	1.2659	5.3275	31.798	14.970	277.14	0.9481	18.9948	282.12
1963	Chinook_1	0.7281	0.7161	0.5206	132.06	143.72	147.68	21.214	32.268	13.963	216.69	0.7789	12.0538	14.064	13.150	12.408	139.78	0.5576	0.9434	5.3607	31.363	15.032	266.95	0.9487	18.8419	273.53
1964	Chinook_1	0.7047	0.7345	0.5169	132.8	145.47	149.83	24.310	32.329	13.752	265.36	0.7702	13.2062	17.291	11.931	11.967	164.33	0.5726	2.1915	5.2363	32.398	14.998	330.01	0.9150	19.8612	341.09
1965	Chinook_1	0.7256	0.7464	0.5408	131.79	142.85	147.36	20.700	33.080	13.338	263.28	0.7616	13.2344	13.837	13.481	11.773	168.62	0.5338	1.5367	5.0482	33.698	14.414	325.70	0.9311	20.5626	331.24
1966	Chinook_1	0.7189	0.6351	0.4559	132.23	144.87	146.87	22.566	32.027	14.493	201.44	0.7738	11.3105	15.347	13.080	12.533	152.66	0.5377	0.8644	5.4517	30.323	15.937	233.41	0.9553	17.4911	239.63
1967	Chinook_1	0.6985	0.7387	0.5152	132.5	146.84	150.54	25.101	32.053	13.298	281.10	0.7640	13.5445	17.909	12.277	11.555	184.34	0.5620	2.8357	5.3839	31.975	14.491	343.96	0.9077	19.9935	352.71
1968	Chinook_1	0.7305	0.7022	0.5122	132.21	142.65	146.71	20.844	32.167	14.458	207.02	0.7783	11.6630	13.618	13.674	12.954	146.57	0.5606	1.3200	5.4545	30.254	15.525	244.52	0.9471	17.7665	254.83
1969	Chinook_1	0.7306	0.7295	0.5322	131.44	141.69	145.04	19.078	34.392	13.775	295.65	0.7539	14.0630	12.465	15.218	12.178	202.98	0.5397	3.4106	4.8133	35.188	14.877	356.36	0.9091	20.5851	361.19
1970	Chinook_1	0.7015	0.7375	0.5166	132.7	146.15	150.08	25.245	31.106	13.013	237.22	0.7779	12.7035	17.869	11.161	11.528	138.56	0.5748	1.4079	5.5497	30.942	14.019	301.28	0.9315	19.7013	308.30
1971	Chinook_1	0.7193	0.7590	0.5451	131.48	142.31	146.12	20.032	34.468	13.173	333.68	0.7474	15.9500	13.487	14.579	11.567	222.08	0.5475	6.1683	4.7227	36.434	14.273	408.30	0.8875	21.8585	413.57
1972	Chinook_1	0.7352	0.7564	0.5553	131.39	141.12	144.89	17.917	35.486	13.620	354.76	0.7512	15.9156	11.478	16.801	12.114	247.43	0.5601	5.4584	4.6293	36.845	14.629	427.80	0.8815	22.1124	427.27
1973	Chinook_1	0.7215	0.7006	0.5047	132.36	143.59	147.85	22.982	30.361	13.633	179.17	0.7817	10.9347	15.211	12.080	12.109	128.84	0.5665	1.1930	5.9685	27.809	14.702	211.94	0.9462	16.5993	217.78
1974	Chinook_1	0.7329	0.7560	0.5533	131.37	140.65	145.02	17.760	35.451	13.607	342.46	0.7518	16.8993	11.363	16.404	12.015	236.86	0.5557	7.9429	4.5901	37.025	14.685	413.84	0.8906	22.3242	417.61

Columbia River System Operations Environmental Impact Statement
Appendix E: Fish, Aquatic Macroinvertebrates, and Aquatic Habitat

Year	Species	InRivSurvUC	InRivSurvLCol	InRivSurv	MedDayRIS	MedDayConfl	MedDayBON	Mean Travel Time	Mean MigRate	Mean Temp	Mean Flow	Mean FSpill	Mean Gas	UC Travel Time	UCMig Rate	UCTemp	UCFlow	UCFSpill	UCGas	LCTravelTime	LCMigRate	LCTemp	LCFlow	LCFSpill	LCGas	BonFlow
1975	Chinook_1	0.7077	0.7582	0.5358	132.42	144.12	149.18	23.626	32.041	13.020	262.54	0.7647	13.1840	16.495	12.243	11.422	165.80	0.5498	2.0216	5.3136	32.211	14.104	325.30	0.9235	19.9959	333.75
1976	Chinook_1	0.7111	0.7645	0.5428	131.81	143.56	147.41	22.473	32.705	12.750	281.27	0.7588	14.0654	15.531	13.140	11.159	186.41	0.5398	3.2052	5.1037	33.547	13.830	346.42	0.9199	20.8984	347.89
1977	Chinook_1	0.7263	0.6651	0.4823	132.36	142.49	146.55	22.936	29.625	14.229	143.20	0.7769	9.1348	14.809	12.222	12.710	114.87	0.5791	0.7990	6.3445	25.368	15.340	161.87	0.9217	13.9110	167.32
1978	Chinook_1	0.7213	0.7219	0.5199	131.72	144.14	147.89	21.943	31.809	13.487	222.45	0.7736	12.0510	14.628	13.400	11.874	157.46	0.5419	0.8639	5.5051	30.486	14.584	263.32	0.9528	18.8633	272.05
1979	Chinook_1	0.7091	0.7164	0.5072	132.42	145.29	148.63	24.349	30.795	13.198	207.54	0.7812	11.7916	16.832	11.660	11.620	136.76	0.5627	0.8892	5.6971	29.622	14.289	254.05	0.9492	18.4080	261.72
1980	Chinook_1	0.7213	0.7435	0.5355	131.72	141.74	145.8	20.773	32.982	13.312	266.12	0.7710	13.9836	13.901	13.349	11.698	187.96	0.5585	3.7817	5.0594	33.533	14.423	320.33	0.9324	20.2788	325.16
1981	Chinook_1	0.7306	0.7147	0.5213	132.2	142.25	146.3	20.411	33.109	14.427	231.76	0.7759	12.6349	13.529	13.738	12.948	156.52	0.5573	2.0496	5.1092	32.620	15.489	280.77	0.9432	18.9613	288.46
1982	Chinook_1	0.7261	0.7446	0.5398	131.9	142.87	146.89	20.367	33.925	13.728	287.10	0.7594	14.1462	13.724	13.850	12.159	181.16	0.5482	3.3024	4.8458	35.106	14.817	358.43	0.9116	20.8245	362.78
1983	Chinook_1	0.7282	0.7487	0.5444	131.79	143.32	148.16	20.933	32.295	13.350	242.33	0.7700	12.5765	13.814	13.261	11.895	146.55	0.5516	1.0380	5.3009	31.986	14.324	303.99	0.9337	19.6711	311.47
1984	Chinook_1	0.7061	0.7315	0.5158	132.64	146.16	150.16	24.454	32.517	13.717	241.05	0.7786	13.0625	17.553	11.550	11.938	126.49	0.5768	1.2873	5.1128	33.282	14.969	316.09	0.9315	20.5321	322.24
1985	Chinook_1	0.7093	0.6983	0.4946	132.41	145.8	148.85	24.258	31.155	13.610	206.31	0.7777	11.5604	16.823	12.050	11.910	138.43	0.5601	0.8478	5.6345	29.747	14.812	249.27	0.9444	18.0113	257.84
1986	Chinook_1	0.7296	0.7122	0.5188	131.78	143.64	147.97	20.818	32.488	13.964	226.78	0.7728	12.2849	13.713	13.678	12.409	143.47	0.5560	1.4199	5.3128	31.545	15.028	280.52	0.9371	18.9587	284.19
1987	Chinook_1	0.7395	0.6218	0.4591	131.59	140.96	142.6	18.569	33.821	15.201	215.17	0.7741	11.6683	11.778	15.452	13.489	174.03	0.5452	1.5319	5.0394	32.465	16.492	243.44	0.9516	17.6601	247.02
1988	Chinook_1	0.7133	0.6961	0.4957	132.31	145.4	149.15	24.170	30.269	13.549	178.57	0.7764	10.5732	16.321	12.141	11.898	132.64	0.5518	0.7887	6.0447	27.540	14.688	208.94	0.9478	16.3222	214.03
1989	Chinook_1	0.7196	0.6968	0.5007	131.87	143.41	146.83	22.322	31.877	13.769	210.49	0.7714	11.5454	15.035	13.155	12.003	155.30	0.5388	0.8796	5.4961	30.431	15.005	247.40	0.9492	18.0019	250.34
1990	Chinook_1	0.7396	0.6416	0.4738	131.66	141.65	144.24	18.892	33.859	15.183	219.07	0.7689	11.7287	12.106	15.292	13.379	166.68	0.5306	1.1741	5.0391	32.572	16.522	254.32	0.9520	18.0359	257.24
1991	Chinook_1	0.7322	0.7316	0.5349	131.53	142.42	146.47	19.750	32.845	13.771	242.38	0.7657	12.5058	12.615	14.759	12.269	178.98	0.5394	2.1957	5.3349	31.707	14.788	285.35	0.9375	18.7535	284.71
1992	Chinook_1	0.7396	0.6162	0.4551	131.81	142.04	144.06	19.561	32.873	15.213	188.21	0.7741	10.7554	12.489	14.729	13.495	146.84	0.5447	0.8245	5.3231	30.628	16.502	215.77	0.9492	16.5797	219.03
1993	Chinook_1	0.6956	0.7076	0.4914	132.86	146.27	149.01	25.909	31.456	13.352	229.95	0.7824	12.4195	18.694	11.228	11.640	142.67	0.5829	1.2508	5.4057	31.397	14.561	288.67	0.9346	19.3524	293.36
1994	Chinook_1	0.7306	0.6133	0.4474	132.13	143.52	145.2	21.130	32.098	14.821	181.86	0.7746	10.6444	13.933	13.388	12.930	137.72	0.5471	0.7812	5.4406	29.984	16.244	210.37	0.9469	16.4179	215.86
1995	Chinook_1	0.7244	0.7344	0.5312	132.24	143.44	148.06	21.749	31.912	13.492	222.59	0.7802	12.3137	14.534	12.724	11.988	141.26	0.5604	0.9530	5.4059	31.280	14.515	275.25	0.9499	19.2911	283.89
1996	Chinook_1	0.7314	0.7436	0.5430	131.57	141.85	145.64	19.151	33.849	13.682	274.52	0.7604	13.4681	12.414	14.961	12.137	187.59	0.5378	2.0902	4.9324	34.169	14.780	330.86	0.9278	20.5021	339.13
1997	Chinook_1	0.7362	0.7603	0.5589	131.39	140.37	143.7	16.977	36.537	13.584	391.05	0.7479	18.1078	10.820	17.177	11.990	273.00	0.5709	9.1834	4.3482	39.127	14.654	471.44	0.8625	23.2975	474.60
1998	Chinook_1	0.7311	0.7322	0.5345	131.61	142.18	146.09	19.591	33.958	13.896	271.90	0.7635	13.2179	12.916	14.251	12.359	172.16	0.5457	1.3610	4.8802	34.800	14.947	337.75	0.9242	20.6100	345.32
1999	Chinook_1	0.7346	0.7375	0.5410	131.62	142.87	147.45	19.530	33.199	13.783	255.14	0.7628	12.8130	12.589	14.531	12.279	164.62	0.5393	1.4704	5.1396	32.817	14.795	314.23	0.9280	19.7695	322.71
2000	Chinook_1	0.7300	0.6434	0.4690	131.77	143.71	145.87	20.606	32.746	14.577	206.83	0.7748	11.6698	13.585	13.992	12.658	150.47	0.5425	1.0183	5.2560	31.311	15.976	242.62	0.9545	18.0308	250.45
2001	Chinook_1	0.7234	0.6686	0.4829	132.41	144.07	147.7	23.172	30.010	14.109	155.35	0.7821	10.0594	15.267	11.936	12.535	112.01	0.5876	1.0988	6.1215	26.601	15.229	183.36	0.9269	15.2122	190.08
2002	Chinook_1	0.7152	0.7233	0.5166	132.07	144.55	148.62	22.504	32.356	13.740	244.89	0.7676	12.6071	15.362	13.268	11.946	172.11	0.5472	2.1425	5.3549	31.437	14.969	291.05	0.9344	18.8518	300.66
2003	Chinook_1	0.7284	0.7229	0.5257	131.77	143.06	147.67	20.925	31.949	13.520	231.38	0.7697	12.0771	13.673	13.432	12.019	154.16	0.5454	1.0993	5.4414	30.831	14.549	277.52	0.9386	18.5800	294.77
2004	Chinook_1	0.7287	0.7015	0.5105	131.83	143.43	147.6	21.562	31.435	13.908	195.40	0.7804	11.3779	14.117	13.134	12.324	130.65	0.5563	0.7314	5.6536	29.355	14.992	232.77	0.9543	17.5300	252.74
2005	Chinook_1	0.7346	0.6861	0.5033	132.2	142.29	145.44	20.527	32.293	14.541	195.07	0.7814	11.3600	13.394	13.553	13.013	132.48	0.5603	0.7877	5.3637	30.645	15.634	236.50	0.9520	17.7652	241.74
2006	Chinook_1	0.7150	0.7327	0.5231	131.91	144.56	147.5	21.868	33.463	13.426	290.90	0.7580	14.0876	15.144	13.551	11.774	189.51	0.5458	2.9935	4.9141	34.507	14.569	358.15	0.9117	20.9630	365.22
2007	Chinook_1	0.7368	0.7000	0.5150	131.64	141.29	144.69	19.466	32.918	14.411	215.20	0.7742	11.6233	12.393	15.053	12.886	163.74	0.5433	0.9740	5.2955	31.117	15.484	248.95	0.9530	17.9834	254.99
2008	Chinook_1	0.7023	0.7296	0.5117	133.07	145.68	149.15	24.512	32.650	13.893	272.19	0.7734	13.9455	17.665	11.572	12.168	153.61	0.5938	3.4750	5.0660	33.448	15.089	347.39	0.9050	20.2384	363.51

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3 Table 4-2. Raw COMPASS data for Upper Columbia spring Steelhead for each of the 80 modeled years by Alternative

Year	Specis	InRivSurvUC	InRivSurvLCol	InRivSurv	MedDayRIS	MedDayConfl	MedDayBON	SAR	TotalReturn	PassageBON	meanTravelTime	meanMigRate	meanTemp	meanFlow	meanfSpill	meanGas	UCTravelTime	UCMigRate	UCTemp	UCFlow	UCfSpill	UCGas	LCTravelTime	LCMigRate	LCTemp	LCFlow	LCfSpill	LCGas	BonFlow
NAA																													
1929	Steelhead	0.666248916	0.632267421	0.420082906	136.36	145.72	151.65	0.014301014	600.7225183	42005.59	23.94157091	26.4358665	13.99201476	166.3359467	0.775805832	9.691797233	14.14921066	20.55641851	12.33746891	98.6544342	0.61981777	2.037271047	7.27105163	22.30390544	15.05918646	209.5929769	0.882057955	13.77533213	219.4393158
1930	Steelhead	0.712967308	0.55750341	0.396383347	135.72	143.33	149.03	0.017082138	677.0669348	39635.96	19.59006698	27.47724043	15.24947821	151.932637	0.766596629	9.518367227	9.472159714	25.14749303	13.34673805	111.9056488	0.58433418	2.427107334	7.591118202	21.14308585	16.46270005	177.4645487	0.892086804	13.20366963	182.6908112
1931	Steelhead	0.713620774	0.547691938	0.389764484	135.64	142.76	148.32	0.01786028	696.0871	38974.03	19.70953019	27.16267787	15.25165424	145.8671473	0.768603154	9.517858187	9.499760568	24.65741456	13.39531784	112.0659241	0.586483845	2.708696938	7.679187	20.80718716	16.45874596	168.3926341	0.895135969	13.04980977	172.1629944
1932	Steelhead	0.737096225	0.683348848	0.502303261	135.48	141.21	146.68	0.018841001	946.324147	50226.85	15.88708223	31.4381677	13.44254354	266.0456665	0.738018397	12.21186514	6.967186421	31.3414316	11.97117825	178.7650574	0.543972299	4.123466873	6.363921016	26.20271368	14.39178276	324.319636	0.861785968	16.26212764	332.2500916
1933	Steelhead	0.732720177	0.666620771	0.487097697	135.51	142.07	148.94	0.01715036	835.3355645	48706.59	16.94489647	30.06588562	13.96810856	244.2289459	0.740083959	11.0784988	7.620649993	29.2026497	12.56655807	157.8198151	0.540554598	2.221878362	6.782396019	24.40085235	14.83907286	292.3617249	0.868396242	15.52876925	310.1208496
1934	Steelhead	0.755555868	0.584945231	0.440739352	135.42	139.56	144.58	0.020779217	915.7596191	44070.94	14.0614596	33.13223363	15.40391134	252.1664825	0.740278889	12.67047021	4.812136382	38.33120302	13.69296455	219.6295837	0.54913058	7.633825493	6.69210349	24.62763003	16.52213891	274.1846008	0.86942485	14.97213769	277.9576416
1935	Steelhead	0.728604005	0.655734277	0.476451452	135.56	142.17	148.45	0.017666009	841.646467	47642.14	17.52596933	29.59107409	14.00331968	216.7183563	0.740591777	9.884119614	8.054477751	28.49260859	12.61131077	150.9014801	0.537154061	1.481090093	6.929287612	23.80931149	14.87994226	256.6369197	0.871747533	14.32162364	268.4041138
1936	Steelhead	0.739398965	0.638674347	0.470931265	135.46	141.02	145.84	0.020318717	956.8083746	47090	15.77655023	31.59009799	14.01704998	262.7528229	0.744238816	12.61262255	6.826883703	32.09139381	12.22638626	183.8270416	0.554455173	5.35094986	6.390983328	25.98713673	15.13846652	314.6864319	0.866269261	16.26391125	321.6843567
1937	Steelhead	0.693029337	0.646021397	0.446474353	135.88	143.99	150.64	0.015347243	685.1716954	44644.61	21.21532558	27.40825692	13.74750551	173.1838664	0.761867088	9.245097649	11.39091042	23.61501647	12.27702713	114.6389847	0.582987019	1.32786659	7.293670282	22.29085171	14.74080515	210.1389338	0.88072441	13.52629677	219.8995514
1938	Steelhead	0.737670054	0.664997513	0.489194644	135.52	141.5	147.6	0.01809395	885.0841979	48916.03	16.10257776	30.87271314	13.87003816	253.5449087	0.735855478	11.47796774	7.024780005	30.46979326	12.28681221	166.0067505	0.534974086	2.926603794	6.527020603	25.45924442	14.86224031	306.8609924	0.863761862	15.72695875	319.5104065
1939	Steelhead	0.718935221	0.594343951	0.426114828	135.54	142.44	147.22	0.018874016	804.1976599	42608.72	18.60987329	28.76502103	14.05104866	188.1709005	0.744894892	9.596116042	8.872346938	27.56703083	11.95338631	143.9221924	0.540690577	1.912691903	7.190128386	22.57274257	15.40090418	217.8930766	0.878573726	13.74942398	221.0480804
1940	Steelhead	0.734537248	0.597387808	0.437591931	135.56	142	147.26	0.018948335	829.1084828	43756.27	17.10760844	29.67758831	14.84078941	204.861263	0.738240819	9.622672804	7.597287029	29.13747302	13.1035984	146.0655823	0.531303808	1.471988845	6.965864226	23.51330272	15.94532235	242.8117956	0.870349338	14.0775671	248.9853668
1941	Steelhead	0.717118652	0.592683247	0.42385017	135.62	142.41	149.26	0.016676536	706.7911115	42382.37	19.22429973	27.56888856	15.01307589	155.7409495	0.767632654	9.375377027	9.188687176	25.07003251	13.63585663	108.6326218	0.590836823	2.128535962	7.506246313	21.46508754	15.97537645	186.2904968	0.888690094	13.20183659	190.9008636
1942	Steelhead	0.696624328	0.686204583	0.476706069	135.88	144.47	150.45	0.015438215	735.9006639	47667.47	20.26621021	28.56490888	13.15611089	211.8618551	0.75419099	9.996490475	10.8436189	25.11101311	11.72654724	130.6556488	0.572223935	1.269269025	6.885605633	24.0041532	14.0560503	263.014979	0.872870535	14.69105522	274.4447937
1943	Steelhead	0.732425905	0.664817012	0.485584891	135.54	142.24	148.47	0.01727234	838.658835	48555.02	16.62929115	30.42930412	13.82936745	243.6681875	0.739531292	11.14815431	7.402001113	29.79753317	12.22018204	161.7753601	0.541861528	2.555113387	6.6817628	24.85380757	14.82806476	291.9827474	0.867534836	15.44693486	306.6471252
1944	Steelhead	0.692560648	0.619214796	0.427658436	136.05	143.96	150.92	0.015302699	654.3896376	42763.02	21.53606313	26.45549948	14.23205802	146.716097	0.775697248	9.384027314	11.38516003	22.17325788	12.80776157	101.3245636	0.608572009	2.22135942	7.625176489	21.05465428	15.16074419	176.2774328	0.89261499	13.14333741	181.5608521
1945	Steelhead	0.712875377	0.64563921	0.458988829	135.61	142.74	148.99	0.017253907	791.8825365	45895.84	18.88072969	28.97907525	14.11456916	217.45837	0.745822423	10.21266678	9.542371064	26.02881466	12.4951416	138.692218	0.554514793	1.683677435	6.801200211	24.27712386	15.16214768	266.2098796	0.868082225	14.72726385	277.750061
1946	Steelhead	0.746836775	0.677463827	0.504558619	135.41	140.05	145.51	0.020143503	1016.287043	50452.35	14.45776622	33.12772414	13.73247776	295.5112508	0.741631071														

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Year	Specis	InRivSurvUC	InRivSurvLCol	InRivSurv	MedDayRIS	MedDayConfl	MedDayBON	SAR	TotalReturn	PassageBON	meanTravelTime	meanMigRate	meanTemp	meanFlow	meanFSpill	meanGas	UCTravelTime	UCMigRate	UCTemp	UCFlow	UCFSpill	UCGas	LCTravelTime	LCMigRate	LCTemp	LCFlow	LCFSpill	LCGas	BonFlow
1971	Steelhead	0.747726792	0.710216644	0.529582271	135.4	139.77	145.28	0.020357062	1077.998668	52954.53	13.84393035	34.09446881	13.13077087	340.2588694	0.744369744	15.9513381	5.427406564	36.71049958	11.67762737	236.0802246	0.573044446	8.313017178	5.847414091	28.51026337	14.00046984	409.0449219	0.856573512	19.61240594	413.5070496
1972	Steelhead	0.755069095	0.702467048	0.528947226	135.39	139.73	144.88	0.020803411	1100.312978	52890.99	13.31399186	35.19468264	13.70050265	370.9874644	0.748230791	16.08858128	5.064956054	39.11563255	12.42215767	254.769754	0.579711235	6.273313332	5.682971701	29.22424097	14.5097092	446.9917094	0.856005132	21.28941536	451.8663635
1973	Steelhead	0.703740018	0.645799712	0.453219025	135.82	142.94	149.54	0.016416294	743.9667382	45318.8	20.25903304	27.27444674	13.78501803	166.3693212	0.763113411	9.087489748	10.33070934	23.75139959	12.56663551	115.4567963	0.582859665	1.280885839	7.391823083	21.90573875	14.60673189	201.3665517	0.883812924	13.35904026	205.3805695
1974	Steelhead	0.754960759	0.694014903	0.522508276	135.4	139.46	145.48	0.01985354	1037.29051	52247.13	13.32982135	34.66225889	13.72484811	334.0091929	0.747666125	16.2336297	4.80408068	39.0782354	12.37538986	248.4130005	0.578480691	10.05655012	5.960028008	27.92063974	14.55406125	389.7421621	0.85863482	18.9741203	393.3178711
1975	Steelhead	0.724037028	0.696123073	0.502626784	135.52	141.59	148.06	0.017760563	892.63578	50259.43	17.25529625	30.70452404	13.22479432	264.45672	0.740508552	11.90583836	8.275148332	29.4441377	11.8523819	171.4280396	0.548068798	3.073636532	6.432547852	25.85863083	14.12095658	324.2441559	0.864576687	16.44610008	332.3302917
1976	Steelhead	0.735963028	0.715458813	0.525097957	135.41	140.54	145.96	0.019724302	1035.650693	52506.33	15.42325316	32.43096204	12.83476823	302.5502848	0.742518206	13.91327359	6.825590581	32.78399816	11.44304523	204.3439575	0.561678591	5.705833817	6.034915537	27.5552897	13.69591379	371.2175293	0.859122396	18.0855484	371.2779236
1977	Steelhead	0.710912428	0.597260368	0.42342644	135.66	142.57	150.2	0.015838834	670.6154303	42339.95	20.16204751	26.71868545	14.54302254	134.3990855	0.775392571	9.504193322	9.694614559	24.23308933	13.3081562	107.3831848	0.598270401	3.281215811	7.93844831	20.03269968	15.46480831	151.3925807	0.901488384	12.53849856	156.6748962
1978	Steelhead	0.732922383	0.673840391	0.492509176	135.49	141.86	147.73	0.018076836	890.2397001	49247.54	16.81588978	30.17957303	13.45775515	227.8380066	0.73650882	10.20794172	7.457956344	29.92905627	11.93985653	163.6359436	0.530047408	1.776420832	6.806488767	24.18409994	14.37095372	269.5780741	0.869096617	14.68859943	277.1608276
1979	Steelhead	0.72089254	0.678863169	0.488035562	135.58	142.36	148.01	0.017970724	876.9799362	48800.48	17.96768662	29.53585026	13.18731937	224.7703054	0.741126523	10.32960835	8.644420475	27.71768236	11.81786098	149.3082123	0.541710985	1.758878517	6.771137014	24.42483744	14.06360865	274.0510813	0.868273109	14.82953342	282.6932983
1980	Steelhead	0.744713142	0.68924943	0.511876731	135.41	139.84	145.75	0.019876501	1017.364382	51184.28	14.82847346	32.32722448	13.48024305	282.7295695	0.745208583	13.57353312	5.966717243	33.76528481	12.19416332	212.0459198	0.564959931	7.107971382	6.299535796	26.47294773	14.31686989	330.8216858	0.862710287	16.57098707	334.6767578
1981	Steelhead	0.733694456	0.638690736	0.467309712	135.54	141.95	148.11	0.017939367	838.2723496	46728.09	16.69970819	30.41980318	14.76949387	242.327183	0.742454346	10.9727573	7.51813978	29.48509475	13.38607063	159.6325623	0.550138479	2.400975251	6.644774809	24.99501457	15.71691799	292.1136627	0.866184215	15.2484266	305.5116882
1982	Steelhead	0.739645065	0.688237635	0.507646235	135.5	141.17	146.76	0.019276811	978.5165528	50761.33	15.43971208	32.291341	13.81149419	303.1015798	0.739511215	13.34367552	6.798196137	32.32462638	12.48287449	193.855069	0.553836486	4.317320538	6.088740692	27.48155227	14.63798491	373.1160736	0.856855869	17.73592575	382.2354126
1983	Steelhead	0.729696053	0.688905634	0.501303291	135.6	142.18	148.59	0.017297363	867.0635355	50126.92	16.77759874	30.40378252	13.5382726	258.6691966	0.738984304	11.51198795	7.754656315	28.66982705	12.32794056	152.7498627	0.545691404	2.181530356	6.474699318	25.75899362	14.31016159	322.7564952	0.860907425	16.22451663	335.8362427
1984	Steelhead	0.700096032	0.671206573	0.468610703	135.91	144.16	150.03	0.015887315	744.4481274	46858.02	19.40159194	29.32825941	13.85539773	241.1227615	0.75501778	11.33712269	10.45581654	24.92446069	12.198386	124.8184753	0.589323971	1.978726029	6.412124053	26.03159967	14.91681019	315.2753245	0.861064424	16.30584717	323.6141968
1985	Steelhead	0.713998028	0.661532928	0.471028672	135.63	143.12	148.6	0.017336258	816.5313585	47099.63	18.60381129	29.50124029	13.65960013	224.3678624	0.746017811	10.31732532	9.296080172	27.44344139	12.13073616	146.2446991	0.553204688	1.610909081	6.763174742	24.48447225	14.60965316	274.124855	0.870183945	14.84425481	285.157196
1986	Steelhead	0.723132266	0.655011167	0.472351465	135.63	142.88	149.15	0.016984868	802.2287923	47231.97	17.64920327	29.60920992	14.16568921	232.9644709	0.746655674	10.81040356	8.418704152	27.42010958	12.81711941	139.5157013	0.559644091	1.775468516	6.688439697	24.74680611	15.01760658	290.2160645	0.866742174	15.51822178	298.473938
1987	Steelhead	0.748833448	0.56489706	0.421846129	135.42	139.83	144.87	0.020697813	873.0695751	42181.73	15.4582967	31.13864022	15.53203526	214.5740835	0.742606234	10.63393593	5.891608685	33.93097645	13.77324429	187.3819122	0.541656119	4.007687378	7.017732695	23.22080626	16.6917909	235.8832677	0.877088298	14.0199585	234.6411133
1988	Steelhead	0.711636167	0.653366038	0.463674457	135.6	142.82	149.01	0.016872578	782.2849523	46364.28	19.46020782	28.5087453	13.61303603	188.8932302	0.744362799	9.231730433	9.707812816	26.61285111	12.08130875	138.2659302	0.541377127	1.208559239	7.212058321	22.64930325	14.55791442	222.6292852	0.875389208	13.58396165	228.153183
1989	Steelhead	0.737465391	0.646518925	0.475468883	135.47	140.89	146.91	0.018576965	883.2155982	47543.59	16.47464682	30.2756181	13.89769929	216.13361	0.737760556	9.898717554	6.983544171	30.82462861	12.30478687	166.9889038	0.531554779	1.825783563	6.939640939	23.67829954	14.90485541	251.0706202	0.871519725	14.23936749	250.9316864
1990	Steelhead	0.742717121	0.571718389	0.423452742	135.53	141.66	147.73	0.018263849	773.3339343	42342.33	16.3176685	30.20555994	15.65222518	214.9676849	0.740011982	9.933166941	6.792673707	30.65183899	13.77896481	158.2018433	0.53609561	1.713493419	6.990459085	23.46302235	16.88228385	248.6991755	0.873397748	14.24313863	255.6394196
1991	Steelhead	0.741465344	0.675874637	0.499754183	135.51	141.31	147.05	0.018837916	941.3653062	49971.84	15.67342669	31.53141744	13.84889488	261.9426666	0.734438916	11.29796646	6.591616184	32.21652364	12.53615265	185.1005768	0.538080281	2.793658686	6.53121081	25.64834345	14.65371593	313.5745494	0.859342734	15.53390813	316.2115479
1992	Steelhead	0.740296022	0.553460323	0.408592902	135.52	141.34	146.85	0.019299141	788.4986401	40856.67	17.02403109	29.36696915	15.58924688	180.3924489	0.744413035	9.336532839	7.166963309	29.75047913	13.76831512	146.7739136	0.535394669	1.920115876	7.318487942	22.16191474	16.7962354	203.795077	0.882519722	13.29239301	204.3605652
1993	Steelhead	0.711867954	0.683067449	0.484910944	135.49	141.71	146.8	0.019193115	930.6334752	48487.88	18.27118358	29.97206633	13.08033695	257.5848226	0.752253222	11.79028829	9.35330084	27.13217271	11.45578976	166.2277435	0.579184666	2.892774487	6.365229264	26.00848796	14.08430147	322.7818247	0.863853246	16.50569455	324.4167175
1994	Steelhead	0.73414348	0.573883272	0.42014921	135.51	141.56	146.81	0.019258625	809.0993273	42012.31	17.45854771	28.96427624	14.97540194	180.5240631	0.747157137	9.095048233	7.600394994	28.63895764	13.18076019	142.7506775	0.542861655	1.193370473	7.314294457	22.13915028	16.13982089	206.3678284	0.882608046	13.42053048	208.6901245
1995	Steelhead	0.726384147	0.67933852	0.492097747	135.59	141.92	148.35	0.017623551	867.1934255	49206.51	17.43239768	29.99157521	13.61644745	234.3488973	0.741769242	10.52377715	8.232925177	28.33702459	12.4109108	150.6513641	0.546948296	1.710015988	6.653371677	24.98243827	14.40143394	287.8851929	0.865792751	15.16698861	297.2565308
1996	Steelhead	0.744245083	0.669429629	0.496844079	135.55	141.33	147.16	0.018309423	909.6293629	49680.94	15.08532096	32.03790281	14.15435359	279.6063812	0.740021197	12.55151273	6.281830579	32.52441571	12.82732506	180.9137268	0.552849376	3.856386805	6.252364606	26.66382287	15.07842382	341.5516357	0.861230403	16.83287557	353.0840759
1997	Steelhead	0.760483612	0.707377996	0.536464853	135.4	139.35	144.12	0.021111276	1132.468403	53642.82	12.46113482	36.35499859	13.74813251	403.4879883	0.755024906	18.8533082	4.491389483	41.14611194	12.44778156	279.3284363	0.599222374	10.04135885	5.398307234	30.49034392	14.55184078	486.9496053	0.853931854	23.6872	

Columbia River System Operations Environmental Impact Statement
Appendix E: Fish, Aquatic Macroinvertebrates, and Aquatic Habitat

Year	Specis	InRivSurvUC	InRivSurvLCol	InRivSurv	MedDayRIS	MedDayConfl	MedDayBON	SAR	TotalReturn	PassageBON	meanTravelTime	meanMigRate	meanTemp	meanFlow	meanFSpill	meanGas	UCTravelTime	UCMigRate	UCTemp	UCFlow	UCFSpill	UCGas	LCTravelTime	LCMigRate	LCTemp	LCFlow	LCFSpill	LCGas	BonFlow
1934	Steelhead	0.755961491	0.584063921	0.440311522	135.41	139.54	144.54	0.020846178	917.8182273	44028.13	14.02913758	33.20454009	15.46854877	252.2846741	0.749399929	12.07905579	4.783104181	38.53490013	13.8103632	219.510495	0.565447277	6.471635818	6.688456044	24.6425	16.5629975	274.4423625	0.878594498	14.75685867	278.3503418
1935	Steelhead	0.725776747	0.655997054	0.474792735	135.58	142.42	148.69	0.017429305	827.4770009	47476.19	17.77610436	29.43452466	13.98925184	214.0510366	0.763643233	9.98213555	8.289106876	28.09272096	12.57679672	147.5612274	0.572376838	1.222186661	6.945953429	23.73847667	14.88241847	254.4031067	0.899480502	14.75189535	266.2869263
1936	Steelhead	0.735383102	0.626681982	0.459579071	135.49	141.43	146.26	0.019905256	914.7456437	45954.98	16.40077031	30.94654396	14.23432617	247.5729533	0.752269701	11.48415869	7.358368576	30.66472581	12.38963375	169.003421	0.567176148	3.522229338	6.48832728	25.51744167	15.41957029	299.2981618	0.875791341	15.68370636	306.183075
1937	Steelhead	0.680777989	0.64071867	0.434981549	136.05	144.67	151.42	0.014603338	635.175967	43495.26	22.46517119	26.77470224	13.78661607	160.3292582	0.802569193	10.00158608	12.52996606	22.19301442	12.29934597	102.8879318	0.641802505	2.021155334	7.409043148	21.84123793	14.80095323	196.5726573	0.931932062	14.33760619	206.0719604
1938	Steelhead	0.735073024	0.664672376	0.487233906	135.54	141.71	147.84	0.017844087	869.3644621	48720.03	16.34452452	30.73418458	13.88410829	249.9189311	0.747993579	11.17104643	7.246473312	30.15270905	12.25903587	161.3380676	0.554839292	2.405498552	6.548958674	25.35891035	14.90878916	303.8532104	0.877267222	15.58980664	316.7480164
1939	Steelhead	0.71053912	0.584188781	0.413942676	135.59	143.04	147.77	0.018296256	757.3080221	41391.42	19.52441205	28.26697769	14.22788537	178.6041728	0.778840085	9.822449168	9.725209355	26.33704166	12.11343822	133.5536835	0.584020326	1.58852241	7.256462932	22.30190405	15.61421537	208.7181218	0.925922235	14.45001419	212.2031097
1940	Steelhead	0.729226085	0.591871132	0.430416029	135.58	142.36	147.54	0.018686657	804.2522085	43038.85	17.61455916	29.24175038	14.90479221	198.4115184	0.762096134	9.502646705	8.062871277	28.02375657	13.11498852	139.080722	0.568556702	1.241550601	7.010143325	23.32001986	16.05770079	236.6725464	0.897894263	14.0791285	243.0126648
1941	Steelhead	0.719140105	0.599118956	0.429660376	135.65	142.36	149.2	0.01671407	718.0902645	42963.22	18.98658477	27.92050823	15.02990246	164.4294317	0.793486157	10.00096847	9.054767698	25.66282667	13.68185692	113.9947937	0.617165321	2.121410608	7.402357772	21.85118721	15.9755791	196.863884	0.931839516	14.29544767	202.4499817
1942	Steelhead	0.681359664	0.68344909	0.464387707	136.17	145.24	151.27	0.014549292	675.6082983	46435.82	21.96917784	27.99338697	13.25075912	206.1176498	0.775358505	10.12412298	12.54414755	23.39914366	11.78355579	122.0077972	0.611649683	1.647056603	6.894549921	23.93026081	14.1910154	259.2985509	0.891154051	14.64186986	271.2261963
1943	Steelhead	0.731920995	0.665448606	0.485711	135.54	142.25	148.51	0.017203364	835.5295605	48567.8	16.65770008	30.39503737	13.81996397	242.9339518	0.754689189	11.02452982	7.428226024	29.70478777	12.17456322	161.2504395	0.564183924	2.006418085	6.684240609	24.84219898	14.84562778	291.1949565	0.886744499	15.68965292	305.7077332
1944	Steelhead	0.680636163	0.615106462	0.417506225	136.21	144.7	151.66	0.014618036	610.2715634	41747.85	22.71233638	25.98500735	14.23422559	138.8846822	0.800926485	9.330326398	12.49799266	21.00201146	12.72571545	93.29890137	0.65243752	2.156852055	7.692898721	20.80690448	15.21889035	168.3666738	0.917974333	13.14553603	173.8861237
1945	Steelhead	0.700937986	0.637571768	0.445663896	135.72	143.7	149.99	0.016251671	724.2300195	44563.42	20.12001558	28.23644948	14.22874419	198.9455729	0.780059477	10.24054069	10.64316753	24.48729778	12.6306303	120.8039581	0.610068831	1.484483314	6.944912776	23.64765347	15.28912385	247.2746989	0.904934873	15.11680508	258.5808716
1946	Steelhead	0.745669371	0.677611812	0.503879972	135.41	140.07	145.56	0.020102297	1012.845975	50384.59	14.56957929	32.98032273	13.74361382	292.8631927	0.746000705	13.30073748	5.770509988	35.26046411	12.1187233	217.3389374	0.567264396	6.158595943	6.239914611	26.82683068	14.74786599	341.1187592	0.86610653	16.52507599	351.6068726
1947	Steelhead	0.743696212	0.623547432	0.462449971	135.43	140.51	145.6	0.020443163	945.3292582	46241.83	15.2569845	31.86143771	14.73530057	260.1961639	0.74330807	11.40544136	6.29557845	32.88798448	13.02330704	185.902298	0.555157608	2.897181463	6.409061506	25.93328384	15.8139631	309.4586334	0.867767711	15.84611233	315.2470703
1948	Steelhead	0.741338484	0.703873924	0.520368326	135.49	141.44	146.71	0.019396263	1009.253536	52033.4	14.80351968	33.42873604	13.68170376	386.2576711	0.747066686	16.54497941	6.582189351	33.51555134	12.0972393	222.0373474	0.575957555	5.210715675	5.665855631	29.36195396	14.68409761	480.006724	0.856156091	22.8041927	509.1902466
1949	Steelhead	0.744018318	0.678588291	0.503488244	135.48	140.82	145.97	0.020152019	1014.562041	50345.43	14.92257887	32.51923955	13.86098995	302.9714681	0.748748881	13.42468328	6.310760021	33.13142786	12.47693367	196.1838379	0.574088693	4.276851368	6.051430613	27.46121814	14.73292081	372.5466258	0.863959372	17.94868724	386.5704651
1950	Steelhead	0.721115399	0.685231212	0.492765894	135.6	142.59	148.63	0.017274496	851.1740383	49273.45	17.59540373	30.4291751	13.53086192	259.5818817	0.750676612	11.23950686	8.541627049	28.84996111	11.98163528	164.633548	0.561874703	2.008624244	6.510371462	25.61962691	14.48646005	316.7729034	0.87767149	15.87712391	334.4163208
1951	Steelhead	0.749075434	0.678786568	0.507059194	135.42	140.06	145.59	0.020021259	1015.12648	50702.43	14.45859043	32.82705943	13.81072566	287.3078674	0.744957849	12.3910898	5.605614334	35.13842802	12.41092281	206.5448944	0.563828263	3.940781355	6.292807028	26.55619092	14.6726621	338.9727834	0.865512222	16.43459272	351.677948
1952	Steelhead	0.739601703	0.695957744	0.513311032	135.44	140.81	146.07	0.019703046	1011.310644	51327.63	15.26743808	32.26095457	13.27368018	294.907014	0.747887922	13.707619	6.603711337	32.51056634	11.74411755	193.4240784	0.573310953	5.692974186	6.102265194	27.34446024	14.20897325	361.0460256	0.861809442	17.59233665	371.1176453
1953	Steelhead	0.731046157	0.694438447	0.506264539	135.51	141.6	148.47	0.017603458	891.143015	50623.18	16.97683172	30.17060549	13.25989106	245.7713938	0.755719091	11.07188155	7.744686514	29.00605368	12.0940733	163.0154449	0.564423937	2.040528154	6.683691725	24.89810024	14.00853491	295.3660177	0.888235052	15.7625947	309.9591675
1954	Steelhead	0.726626625	0.707180706	0.512437371	135.5	141.55	147.16	0.01861025	953.5949587	51240.31	16.68677327	31.47625614	13.03121974	283.297641	0.750771422	12.62438984	7.852842391	30.94192975	11.59326839	194.5464233	0.573437887	4.292617416	6.28116253	26.59574912	13.93154033	342.0055288	0.869991849	16.68941315	353.788208
1955	Steelhead	0.703947312	0.687839971	0.482865201	135.76	143.34	150.16	0.015697026	757.9054537	48283.38	19.62620649	28.84262117	13.25773195	225.3658808	0.771314859	10.72172373	10.2834886	25.56353945	11.87989464	140.8413895	0.595586392	1.688720703	6.807484493	24.30216022	14.16974767	276.6317266	0.897071878	15.53551141	292.148407
1956	Steelhead	0.747019817	0.712525837	0.530801856	135.45	140.72	145.77	0.019709015	1046.084734	53076.46	14.03164904	33.83810543	13.18262208	356.0410197	0.746172652	15.02287742	5.678385377	35.57629226	11.66764774	227.9602325	0.573325825	5.033572626	5.786572263	28.78856139	14.09737047	433.9434102	0.859913141	19.86585951	456.481842
1957	Steelhead	0.740964678	0.714431517	0.527907254	135.4	140.36	145.32	0.02073014	1094.288736	52787.33	14.63010326	33.51464807	13.08073457	352.5451569	0.751279177	16.06809855	6.360183537	34.25545301	11.72039337	222.8880798	0.586683914	7.11355238	5.701813638	29.09570871	13.94774961	436.5216726	0.858294149	20.50478506	449.8237305
1958	Steelhead	0.731544248	0.690168424	0.503494545	135.49	141.64	146.78	0.019394206	976.4230088	50346.12	16.11090481	31.86719697	13.53305473	310.1675741	0.752532924	13.88613036	7.550737411	30.67155286	11.99621887	184.9497131	0.582372305	4.605852509	6.004656538	27.82822918	14.48998213	387.6550802	0.863956064	18.40146955	405.7329407
1959	Steelhead	0.744223924	0.675093055	0.501033172	135.49	141.05	147.34	0.018524394	928.0702681	50099.9	15.43478796	31.60555216	13.84851723	260.0742757	0.747702416	10.88944625	6.294395894	32.86720169	12.45721016	188.3616241	0.55540041	1.838074422	6.588491201	25.30558652	14.71043142	304.4941508	0.879435927	15.59630481	315.7140503
1960	Steelhead	0.729282772	0.676434071	0.491949536	135.45	141.39	147.94	0.017738641	872.5938983	49191.7	17.0824355	30.24464535	13.40546042	233.0194295	0.751762554	10.21911643	7.736031502	29.9284266	11.86431484	168.0932617	0.556049529	1.614935684	6.798701704	24.30661518	14.4034907	274.3752136	0.88666295	14.75697033	

Columbia River System Operations Environmental Impact Statement
Appendix E: Fish, Aquatic Macroinvertebrates, and Aquatic Habitat

Year	Specis	InRivSurvUC	InRivSurvLCol	InRivSurv	MedDayRIS	MedDayConfl	MedDayBON	SAR	TotalReturn	PassageBON	meanTravelTime	meanMigRate	meanTemp	meanFlow	meanFSpill	meanGas	UCTravelTime	UCMigRate	UCTemp	UCFlow	UCFSpill	UCGas	LCTravelTime	LCMigRate	LCTemp	LCFlow	LCFSpill	LCGas	BonFlow
1975	Steelhead	0.723940655	0.69592761	0.502418769	135.53	141.68	148.25	0.017569394	882.6619389	50238.61	17.29453312	30.67354338	13.22305965	260.8339528	0.750587648	11.41659011	8.28496471	29.50456319	11.81695175	167.9441833	0.565068257	2.01003859	6.46275574	25.72223378	14.14494228	320.2902934	0.875229607	16.32923913	328.4494019
1976	Steelhead	0.735116126	0.714112657	0.523506645	135.42	140.61	146.07	0.019591632	1025.567261	52347.21	15.54195012	32.28476717	12.91067257	297.7660899	0.745738036	13.29586832	6.920988381	32.45598261	11.47464523	200.037323	0.569758934	4.857338476	6.060012117	27.44386779	13.81005367	366.169342	0.860425095	17.58575551	366.1081848
1977	Steelhead	0.701173877	0.595300195	0.416254938	135.77	143.17	150.98	0.01511831	629.267162	41622.85	21.13912655	26.11245104	14.57763309	124.3103658	0.81220937	9.796126032	10.56580177	22.77907869	13.39992752	96.21108551	0.648652804	3.25969491	8.048148036	19.68627029	15.47257217	141.5754801	0.949948857	13.25398016	147.4373016
1978	Steelhead	0.733263964	0.672637043	0.49185843	135.5	141.8	147.68	0.018175473	893.9164842	49182.57	16.76559794	30.23062833	13.54115206	228.7969106	0.751054306	10.12085869	7.422049612	30.01078253	12.02319489	164.7418213	0.554044777	1.609491348	6.792441517	24.23999352	14.47251622	270.3425954	0.885666341	14.67761238	277.9974365
1979	Steelhead	0.716203475	0.674206276	0.481534907	135.58	142.58	148.29	0.017724535	853.4413427	48150.28	18.48992988	29.06446994	13.2768933	215.3370926	0.763586886	10.3685926	9.104765654	26.61805679	11.86119785	141.2717438	0.577083516	1.562415624	6.83632451	24.1266138	14.19620069	264.0232875	0.893697202	15.13386273	272.0703735
1980	Steelhead	0.742607282	0.690404534	0.51128449	135.42	139.99	145.98	0.019676299	1005.952346	51125.08	15.02084301	32.10217082	13.43637174	277.4212321	0.749493296	12.79549173	6.123152882	33.27484802	12.08875427	206.5235748	0.570193323	5.634774494	6.336745128	26.30517038	14.30876176	325.5943298	0.870267212	16.30209096	329.4769897
1981	Steelhead	0.731314162	0.639184069	0.466153331	135.57	142.16	148.35	0.017705669	825.3053295	46612.49	16.95422973	30.21778151	14.82651227	238.5808431	0.760664932	10.82559754	7.749398559	28.98775437	13.52991676	154.538028	0.581978992	1.983442688	6.669192299	24.89170638	15.73038149	289.143987	0.884458164	15.35635654	302.8158264
1982	Steelhead	0.737908899	0.690154564	0.507865151	135.52	141.34	146.94	0.019104649	970.1950407	50783.19	15.58169113	32.11504694	13.78378874	299.4672882	0.747443687	12.96844392	6.921873599	31.89169574	12.42909718	190.375589	0.569066772	3.834523535	6.107728794	27.39414664	14.62689654	369.7085215	0.864280164	17.41625261	378.5730896
1983	Steelhead	0.726473264	0.690814703	0.500472533	135.63	142.41	148.83	0.017044184	852.956261	50043.83	17.05711751	30.20725998	13.48657602	255.1877258	0.756859813	11.28131866	8.017829031	28.155668	12.21772118	149.2297546	0.574825504	1.596666479	6.492444471	25.68089587	14.29078722	319.5974223	0.880802761	16.30057089	332.4447632
1984	Steelhead	0.69583197	0.671078649	0.465667497	135.99	144.34	150.25	0.015707047	731.3742865	46563.45	19.88609932	29.20207501	13.92570972	239.7854416	0.767456534	11.14911809	10.94894049	24.49705053	12.29502869	121.6519623	0.609475446	1.593897247	6.405852899	26.04641992	14.98973672	315.1598155	0.874638865	16.31892141	323.7921448
1985	Steelhead	0.709873976	0.657256047	0.46528007	135.68	143.37	148.89	0.017000423	790.9412858	46524.8	19.03785613	29.20508402	13.74034074	218.4542786	0.764781734	10.22580787	9.697623342	26.71900774	12.14514694	140.492981	0.584824336	1.271317136	6.798558682	24.31627897	14.7444191	268.2384364	0.889916897	15.05992508	279.1360779
1986	Steelhead	0.717637318	0.65632512	0.469702679	135.66	143.25	149.48	0.016664787	782.6982156	46967.19	18.08171935	29.45200386	14.12713299	233.9940379	0.765042679	10.86157145	8.862797588	26.90372012	12.70685253	137.7142487	0.591265616	1.696283555	6.678690761	24.76392236	15.02519162	292.6868846	0.885796547	15.67964546	301.7268066
1987	Steelhead	0.747820581	0.557271667	0.415588691	135.43	140.06	145.17	0.020438777	849.3542455	41556.02	15.79176158	30.64439564	15.64163462	202.1183757	0.769634501	10.29887017	6.107631505	32.9934706	13.92180824	175.3839661	0.57231639	2.722377729	7.136979133	22.74680569	16.79149342	222.9511719	0.917878519	14.39505569	221.6410828
1988	Steelhead	0.701494193	0.639325839	0.447244207	135.7	143.53	149.82	0.016043964	717.5078894	44721.36	20.43960604	27.59229247	13.73958276	165.1197225	0.779054051	9.397430364	10.45201007	24.90367587	12.13502598	118.9304535	0.600218099	1.888688493	7.452152014	21.72892757	14.74950695	195.8474782	0.91130057	13.39119705	200.2751465
1989	Steelhead	0.736432873	0.646132408	0.474519516	135.48	140.97	147.04	0.018465497	876.1638093	47448.7	16.61142357	30.14874241	13.90758743	214.0924876	0.760996112	10.05565242	7.106978416	30.50082847	12.27701874	164.5399689	0.561670601	1.418253696	6.954004452	23.61987964	14.94503419	249.1176402	0.904241651	14.81932314	249.1729889
1990	Steelhead	0.74072429	0.568282001	0.419777984	135.54	141.86	147.95	0.01812583	760.8302767	41974.92	16.54796779	29.97363983	15.75924447	210.8787282	0.760562567	9.961048675	6.99199152	30.10112236	13.93418026	152.992334	0.568900195	1.704111409	7.023113877	23.3237363	16.97267056	245.1293106	0.896733026	14.32539042	252.431015
1991	Steelhead	0.740522148	0.676872743	0.49985549	135.51	141.39	147.13	0.01876521	937.9257118	49982.16	15.74758144	31.50403069	13.82052212	260.3703857	0.745525141	10.99984498	6.655204028	32.18565748	12.48533764	183.8967285	0.558854726	2.193667459	6.541957244	25.60367115	14.64191564	311.8215892	0.86983041	15.49924978	314.3146057
1992	Steelhead	0.736544405	0.54662826	0.401504205	135.54	141.68	147.23	0.019003743	762.9575383	40147.75	17.48427443	28.90300688	15.71676184	171.7614136	0.769943072	9.844071325	7.554618031	28.6646377	13.93050938	137.448645	0.576286435	2.9368536	7.393821597	21.87675613	16.91829459	195.5027186	0.910941521	13.4131248	196.324295
1993	Steelhead	0.708676739	0.682855146	0.482586481	135.5	141.83	146.95	0.019005766	917.1321531	48255.47	18.59683076	29.69958237	13.08470828	252.8544617	0.760628814	11.4346348	9.651768029	26.45344438	11.429245	161.800766	0.595681712	2.141694283	6.393825933	25.87746185	14.10973565	318.0155436	0.871447752	16.45768118	319.4374695
1994	Steelhead	0.723063025	0.5581925	0.402493675	135.54	142.46	147.62	0.018408206	740.8717416	40246.82	18.60919869	28.03929608	15.12649097	162.1389191	0.777600157	9.261930116	8.589506716	26.53498443	13.25218601	124.3155151	0.594181588	1.711952829	7.482076317	21.51167665	16.36615276	187.7415746	0.913554182	13.40010826	190.3322144
1995	Steelhead	0.723253381	0.680483446	0.490802556	135.61	142.15	148.62	0.017391177	853.5057486	49076.94	17.72822282	29.76843517	13.5657608	231.1767766	0.75850865	10.54691474	8.509960949	27.75943559	12.29454556	147.1356812	0.574446118	1.492329192	6.673694119	24.88917543	14.38775889	284.9125315	0.884159466	15.45041227	294.349823
1996	Steelhead	0.744451269	0.671357124	0.498412889	135.55	141.3	147.15	0.018339909	914.0205362	49837.79	15.10324872	32.00024304	14.17181498	278.0722076	0.746570926	11.8805961	6.290042639	32.45574281	12.87051105	179.508252	0.562551942	2.451585579	6.262383997	26.62359818	15.07900127	339.9108124	0.869830618	16.63397209	351.4550781
1997	Steelhead	0.759406136	0.710728329	0.538242177	135.4	139.41	144.21	0.021123832	1136.896912	53820.58	12.59387761	36.14788214	13.70563189	401.4917257	0.755872125	18.08695113	4.617053866	40.5523534	12.31982517	276.6596191	0.60516018	9.349642372	5.406578556	30.45461244	14.56077115	485.2970327	0.850854923	22.59066248	489.7820129
1998	Steelhead	0.740836237	0.677845622	0.500786255	135.46	140.9	146.83	0.019214487	962.1710279	50075.29	15.38906737	31.92944976	13.93649508	277.7684652	0.744834144	12.31148656	6.582476825	32.16710253	12.57862549	181.7385437	0.561592835	3.771466732	6.251634091	26.73183386	14.79480251	339.9185537	0.865928411	16.590048	346.9322815
1999	Steelhead	0.735093697	0.676487099	0.495908214	135.6	142.03	148.27	0.017439675	864.788139	49587.4	16.33948207	30.67140852	13.88670432	257.4612701	0.753630874	11.352882	7.25646466	29.79079403	12.52907791	160.3992889	0.56540533	1.87913537	6.536237225	25.47814568	14.71827666	315.3353119	0.882385125	16.16549087	330.4488831
2000	Steelhead	0.735535896	0.60446057	0.443374636	135.55	142.21	147.43	0.018423072	816.776405	44334.43	16.81892711	29.85983244	14.73296127	211.0633657	0.755958539	9.810965625	7.348065734	29.48462222	12.90702133	150.4062592	0.559067982	1.539961648	6.926344007	23.68033663	15.88602861	249.0982615	0.89222	14.28555822	258.6538391
2001	Steelhead	0.691926697	0.61405737	0.42370806	135.91	144.12	150.4	0.015634708	662.410386	42367.94	21.57179771	26.47305553	14.29405759	144.5669769	0.80675674	10.14044511	11.41106933	22.31710768	12.830793	100.4423141	0.64506861	2.918530941	7.633594334	20.99426634	15.23573621	174.1691895	0.939139952	14.05438439	179.9941559

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Appendix E: Fish, Aquatic Macroinvertebrates, and Aquatic Habitat

Year	Specis	InRivSurvUC	InRivSurvLCol	InRivSurv	MedDayRIS	MedDayConfl	MedDayBON	SAR	TotalReturn	PassageBON	meanTravelTime	meanMigRate	meanTemp	meanFlow	meanFSpill	meanGas	UCTravelTime	UCMigRate	UCTemp	UCFlow	UCFSpill	UCGas	LCTravelTime	LCMigRate	LCTemp	LCFlow	LCFSpill	LCGas	BonFlow
1930	Steelhead	0.701735457	0.530319939	0.371628514	135.74	144	149.51	0.016595997	616.7239962	37161.01	20.36093049	28.0099369	15.29977932	141.1355331	0.721551086	4.107474045	10.51846302	24.53792252	13.36850834	100.7247391	0.569558659	0.483364183	7.474458709	21.81903429	16.56464275	166.9607112	0.790191034	5.538528626	172.0896301
1931	Steelhead	0.709884908	0.526266288	0.373070815	135.57	143	148.44	0.017688267	659.8629099	37305.12	19.7641854	28.14335405	15.23445085	140.5105097	0.719074879	4.111737883	9.8699449	25.26043544	13.36428356	106.9254456	0.559559712	0.453558123	7.519661866	21.62941169	16.46940072	163.0210241	0.793037603	5.609098077	166.5128632
1932	Steelhead	0.741242166	0.668853974	0.495096557	135.38	140.9	146.21	0.019246385	952.8167149	49506.27	15.27293703	33.24389021	13.42969799	268.3773122	0.729359443	4.304923769	6.732780114	33.4341546	11.95474186	181.250705	0.543521011	0.534649611	6.137460768	27.90115827	14.3839585	326.6651357	0.837489396	5.875922511	334.4804077
1933	Steelhead	0.730011356	0.647488709	0.472019741	135.43	142.38	149.2	0.016925743	798.8769775	47198.93	16.83109494	31.35285258	13.88748474	241.21008	0.719087151	4.860864548	7.857707441	30.12232516	12.46108742	153.6252869	0.521990621	0.64907009	6.587180153	25.73941758	14.77881845	290.5066986	0.830929577	6.555268819	308.3908081
1934	Steelhead	0.758229826	0.575046808	0.435414979	135.32	139.37	144.3	0.021021953	915.2649129	43538.53	13.53179042	35.04694629	15.37748362	252.9329702	0.718475722	4.455481029	4.64803955	41.03015891	13.76438408	219.7687286	0.537731543	0.919653499	6.479371831	26.09948665	16.43970617	275.3416087	0.824510326	5.950516274	279.2550659
1935	Steelhead	0.730111934	0.635630847	0.463443941	135.48	142.11	148.37	0.017764825	823.2502325	46341.59	17.06883478	31.01798127	13.8896197	215.6891866	0.709250459	4.154382523	7.94291836	29.93278629	12.46920757	150.5516479	0.510338753	0.475364321	6.737389207	25.08770048	14.78732411	255.2128499	0.815889418	5.635351643	266.8375244
1936	Steelhead	0.738222733	0.61542213	0.453690058	135.39	141.22	146.02	0.020130147	913.2264815	45366.11	15.86659377	32.65820832	14.16205527	248.889858	0.728127098	4.250532925	7.187195867	32.63169576	12.35305614	171.1266052	0.548482883	0.53425175	6.27887585	27.08073576	15.32417027	300.0118052	0.829291334	5.839751263	306.9619751
1937	Steelhead	0.68883542	0.614708064	0.422845599	135.86	144.11	150.7	0.015285345	646.2970762	42282.14	21.37337502	28.29018829	13.7584547	165.1030828	0.711290312	4.167303824	11.83359289	23.89937801	12.27882862	107.8432144	0.556674328	0.510610908	7.165395685	23.12762329	14.76352056	201.3073705	0.775381227	5.577117488	210.7129822
1938	Steelhead	0.738975945	0.648301521	0.478416089	135.43	141.41	147.51	0.01808312	865.0671822	47838.38	15.71194328	32.47241376	13.83894463	251.8873088	0.720866787	4.27842687	6.989637583	32.1861315	12.24568157	163.511261	0.526871639	0.626876891	6.325947613	26.93839856	14.84284623	305.9692332	0.831979285	5.749797851	318.4305725
1939	Steelhead	0.713924203	0.569441697	0.405975318	135.5	142.79	147.46	0.018621734	755.9539514	40595.25	18.90561754	29.68372534	14.12984937	180.2742788	0.711191536	4.153165459	9.476852119	27.8374833	12.06771507	135.4312988	0.516636497	0.438815686	7.038685724	23.51718745	15.48387941	210.3818054	0.813159337	5.637084126	213.6755524
1940	Steelhead	0.731637513	0.575332219	0.420351725	135.49	142.17	147.32	0.018895588	794.2293542	42032.53	17.09279717	30.74250226	14.81484706	198.6332001	0.707310464	4.24092387	7.899006158	29.68947357	13.06100407	139.5176483	0.515349314	0.470339608	6.805519223	24.59928452	15.94726992	236.806071	0.805331737	5.754237145	242.9854279
1941	Steelhead	0.72252928	0.575926085	0.415547088	135.55	142.07	148.73	0.017160549	713.0614961	41552.37	18.38499727	29.30219466	14.96972078	165.4591705	0.702125602	4.313534184	8.815049797	27.13111358	13.63535175	115.7338135	0.536828229	0.473159647	7.193352126	22.99136364	15.89839268	197.5918477	0.770646602	5.873046031	202.9403992
1942	Steelhead	0.690772913	0.65942592	0.454882542	135.88	144.74	150.75	0.015156528	689.3992062	45485.3	20.63638418	29.60365855	13.20885181	207.3892349	0.722426543	4.128144664	11.54565161	25.4301646	11.74190102	126.6974701	0.559014925	0.472657394	6.711850204	25.18914129	14.14566867	258.1542791	0.803723921	5.536954984	269.9503479
1943	Steelhead	0.732685158	0.646510854	0.473033512	135.45	142.31	148.48	0.017198332	813.4819713	47300.05	16.33492913	31.87780962	13.80268396	242.5392354	0.720189657	4.258398736	7.465951562	31.10203049	12.18167439	158.9868378	0.528259456	0.620776236	6.478526458	26.28567364	14.81575282	291.9714203	0.828730414	5.741960029	307.166687
1944	Steelhead	0.688848721	0.596796371	0.410532137	136.01	144.14	150.98	0.015292226	627.7601004	41050.93	21.57803766	27.45567225	14.14154924	144.2214539	0.722192373	4.144937758	11.76523724	22.6805251	12.65795784	98.76179199	0.575439698	0.513810164	7.442554325	22.00721205	15.10642735	173.7319132	0.786115229	5.558792735	179.1306305
1945	Steelhead	0.711506371	0.621937103	0.441899333	135.54	142.82	149.15	0.017094246	755.3537249	44187.6	18.81088713	30.02422457	14.10860513	207.3230647	0.719090196	4.169091985	9.736904263	26.71968232	12.51672859	132.1488419	0.540188333	0.463386926	6.692730784	25.19454601	15.15376091	254.0021667	0.81234766	5.644954567	265.0134277
1946	Steelhead	0.748732634	0.664748421	0.497030692	135.32	139.85	145.23	0.02036762	1012.26319	49699.63	14.02876852	34.89925435	13.70456352	294.397934	0.733889753	4.540838973	5.602309644	37.62177354	12.11241894	218.4538879	0.554099116	0.913278031	6.020437755	28.58879868	14.68822241	342.9405721	0.845422645	6.029005865	353.3635864
1947	Steelhead	0.747859266	0.61498367	0.45928535	135.32	140.2	145.22	0.020760471	953.4329164	45925.4	14.61156607	33.78470788	14.62777678	264.4725657	0.725288096	4.857750642	6.041029304	35.27209134	12.95992546	189.6972748	0.544615009	0.811617303	6.170455955	27.69150078	15.6819733	314.0943502	0.828412344	6.460438718	319.7397156
1948	Steelhead	0.74509853	0.687187053	0.511314092	135.4	141.25	146.45	0.019652868	1004.812405	51128.03	14.29896434	35.25985456	13.61715692	384.5147552	0.743220105	4.332387845	6.42033726	35.54653693	12.04104023	221.8281799	0.559948024	0.510896754	5.476662211	31.17215194	14.61391592	477.5983887	0.856788556	5.922847609	506.401001
1949	Steelhead	0.747069089	0.668837091	0.498976028	135.39	140.51	145.48	0.020593972	1027.518519	49894.14	14.35909607	34.4292505	13.78811887	309.4203176	0.745670268	4.270611101	6.15396373	35.27130687	12.43219662	200.6044739	0.569505838	0.611705333	5.797665097	29.38900228	14.64255889	380.6519165	0.85503309	5.7964332	394.5062561
1950	Steelhead	0.722547918	0.668695458	0.482495475	135.51	142.39	148.32	0.017558665	847.1471144	48246.67	17.1191821	32.09704553	13.46055158	263.1293304	0.723670315	4.711746083	8.462645203	30.46738596	11.90654449	165.9089172	0.533781201	0.496345431	6.266946465	27.35206831	14.42037582	322.0152842	0.83367455	6.391334494	339.8640747
1951	Steelhead	0.751963729	0.666571843	0.500544438	135.32	139.86	145.32	0.020284432	1015.259545	50051.17	13.93811894	34.69518397	13.74872831	289.0708506	0.732095886	4.661529599	5.459731549	37.3829891	12.37084942	207.6103546	0.546477103	0.609503096	6.071514785	28.2874288	14.59895515	340.9951884	0.846396943	6.17059498	353.8208618
1952	Steelhead	0.74292289	0.684764247	0.508023262	135.34	140.65	145.81	0.019935059	1012.67866	50798.88	14.77644666	34.03251892	13.23551826	295.2236298	0.747273346	4.368876994	6.476564229	34.41913349	11.72512054	193.0536407	0.570204577	0.960765707	5.892020732	29.11191915	14.16051372	361.6586812	0.857685695	5.762241642	371.8828735
1953	Steelhead	0.735422731	0.674432409	0.495306471	135.4	141.27	147.98	0.018013875	892.1843733	49527.62	16.22185951	31.94899786	13.22112522	249.0426992	0.717300319	4.211662275	7.376523793	31.13762318	12.0574316	167.3440155	0.521007341	0.417103285	6.449578755	26.49610799	13.9666543	298.404068	0.828936944	5.747068167	312.523468
1954	Steelhead	0.730258249	0.691672314	0.504400408	135.39	141.31	146.78	0.018986875	957.6421521	50437.06	16.06033798	33.322537	13.00798702	284.7764404	0.736139731	4.408386219	7.59912549	33.13834597	11.57500515	195.4203278	0.551741028	0.469344145	6.061651252	28.30719462	13.90595261	343.7560577	0.851101021	5.96639429	355.5675049
1955	Steelhead	0.706830675	0.663558286	0.468373286	135.64	143.1	149.78	0.01605282	751.8270909	46834.58	19.03872238	30.34682517	13.25732002	227.2908432	0.71662886	4.500910481	10.08379683	26.93644708	11.88541946	141.2628799	0.545721763	0.474549806	6.573789813	25.81858409	14.16415564	279.7084656	0.802030404	6.034395844	295.3250427
1956	Steelhead	0.749313327	0.697479287	0.521907834	135.37	140.62	145.57	0.019856251	1036.239977	52187.09	13.58936895	35.68863428	13.15142059	355.767509	0.742214268	4.500895699	5.596609175	37.62084296	11.65321732	226.4433197	0.558194041	0.82163763	5.580027528	30.64050935	14.05820608	434.3983358	0.861694217	6.005953352	457.10

Columbia River System Operations Environmental Impact Statement
Appendix E: Fish, Aquatic Macroinvertebrates, and Aquatic Habitat

Year	Specis	InRivSurvUC	InRivSurvLCol	InRivSurv	MedDayRIS	MedDayConfl	MedDayBON	SAR	TotalReturn	PassageBON	meanTravelTime	meanMigRate	meanTemp	meanFlow	meanFSpill	meanGas	UCTravelTime	UCMigRate	UCTemp	UCFlow	UCFSpill	UCGas	LCTravelTime	LCMigRate	LCTemp	LCFlow	LCFSpill	LCGas	BonFlow
1967	Steelhead	0.716316868	0.679382565	0.485979519	135.46	142.71	148.18	0.017851199	867.4809598	48595.11	17.58272161	32.22587331	13.00570793	278.9746399	0.72705792	4.248102711	9.012293935	30.39138558	11.33676472	179.2835083	0.539212751	0.405901748	6.177339472	27.77880121	14.02931118	340.5932515	0.836588383	5.759919375	353.0355225
1968	Steelhead	0.718247206	0.609742049	0.437339014	135.6	142.58	149.05	0.01692805	740.2880123	43731.44	18.30524102	30.30526505	14.80861117	210.950086	0.723436239	4.561456045	9.193224251	27.79671056	13.4675705	139.3312714	0.550788483	0.497969824	6.737368315	24.92078833	15.74935754	253.7348175	0.814945926	6.152745023	267.5537415
1969	Steelhead	0.751161539	0.672717795	0.504620423	135.33	140.1	145.37	0.020517061	1035.262398	50458.61	13.84433649	35.18619252	13.79057674	313.6116648	0.740071119	4.311998828	5.636898309	37.33847645	12.42011414	212.9472321	0.555023888	0.584247279	5.799431145	29.56524033	14.65188551	380.0574697	0.857482105	5.877703865	385.5653381
1970	Steelhead	0.697790362	0.675265771	0.470540638	135.7	143.8	149.5	0.016503464	776.5089307	47051.27	19.59269039	30.46989166	13.05637582	246.1043401	0.738551396	4.170832989	10.92619148	25.66077378	11.76214085	136.0611282	0.576696298	0.456311885	6.278735593	27.26777107	13.89557441	315.8570964	0.829143465	5.656515976	326.5307922
1971	Steelhead	0.749580841	0.697321427	0.521975838	135.3	139.59	144.97	0.020579234	1074.112528	52194	13.39359394	36.00843594	13.16196842	339.5226817	0.743634666	4.374583991	5.345023185	38.90244741	11.70459366	234.1515747	0.567759117	0.773643541	5.633992083	30.39345862	14.05352052	409.3042857	0.859379838	5.840993543	413.7596741
1972	Steelhead	0.757010003	0.691373944	0.522653686	135.29	139.54	144.59	0.021054697	1100.355334	52261.75	12.83343517	37.23614819	13.59279124	370.6481038	0.748372458	4.405650636	4.926488742	41.80361501	12.27941818	254.9835754	0.573398921	0.501276445	5.494590648	31.01970813	14.42817879	445.9941559	0.86214597	6.045664618	451.3241882
1973	Steelhead	0.710886822	0.629256083	0.44670977	135.73	142.53	148.9	0.017032984	760.8405615	44668.66	19.16794667	29.2429765	13.64495932	181.97503	0.706826813	4.228491642	9.750888228	26.22397452	12.38467999	127.6611984	0.542711759	0.475968468	7.032053098	23.6988076	14.4796141	218.9488627	0.777940283	5.711483891	224.0010071
1974	Steelhead	0.755705338	0.682243593	0.51486224	135.31	139.42	145.48	0.019885425	1023.754995	51482.68	13.04310874	36.30428489	13.62991168	328.2754079	0.74181779	4.535448162	4.822542265	40.9048524	12.25010738	243.3083221	0.569735545	1.090426266	5.809584364	29.42304478	14.48233414	383.0898438	0.851946046	5.935162574	387.4555969
1975	Steelhead	0.729146744	0.678216398	0.493834568	135.43	141.35	147.73	0.018033799	890.5192648	49380.57	16.53001638	32.45833113	13.21164163	264.0144643	0.726881192	4.789744588	7.911414593	31.52273995	11.81512604	171.1189789	0.540782076	0.521900308	6.224713035	27.42664588	14.1244057	323.9810994	0.834306349	6.442512949	331.7488403
1976	Steelhead	0.738655798	0.701848023	0.51770734	135.32	140.36	145.65	0.019996465	1035.164616	51767.38	14.93537561	34.20328819	12.88383191	301.3109222	0.741769209	4.349234804	6.70131059	34.69693465	11.45745449	202.1529022	0.557777214	0.507131016	5.826039709	29.30911837	13.77839899	370.5751953	0.859417647	5.941700538	370.5142822
1977	Steelhead	0.708464107	0.578941759	0.409590771	135.62	142.68	150.23	0.015822882	648.0557375	40956.87	20.13784872	27.56585078	14.5366443	128.6800145	0.729894622	4.239227064	9.961342096	24.58351808	13.34515038	101.3874268	0.575903293	0.539688504	7.803064898	20.73548007	15.42726882	145.6579336	0.805591901	5.668177138	151.1134033
1978	Steelhead	0.735966707	0.655665173	0.481880232	135.4	141.52	147.27	0.01856168	894.3928687	48184.91	16.16794188	31.91260605	13.45873362	231.7031993	0.714606009	4.349547647	7.21333167	31.9280988	11.94487133	167.1603607	0.519574443	0.39961181	6.556360848	25.77592969	14.38803832	273.7194977	0.82353884	5.890541211	281.3710938
1979	Steelhead	0.720582904	0.652595164	0.469597672	135.47	142.32	147.91	0.018096857	849.7752042	46957.06	17.80240362	30.68258776	13.24092236	217.0051432	0.71435539	4.160635696	8.786822289	28.47994081	11.83552513	143.5424652	0.533192867	0.453604943	6.619547397	25.54817253	14.15100304	265.4264704	0.80669709	5.655842483	273.1965332
1980	Steelhead	0.745997759	0.6757726	0.50342744	135.32	139.7	145.5	0.020060918	1009.857782	50339.56	14.39880897	34.01357846	13.39022535	282.7061839	0.731932635	4.385419879	5.903732672	35.53687742	12.04668217	210.903186	0.557496569	0.754763812	6.086685099	28.13944216	14.25919978	331.6788584	0.83617265	5.891716172	335.3459473
1981	Steelhead	0.734239451	0.622531972	0.456454652	135.46	142	148.19	0.017904475	817.2083939	45642.69	16.40122579	31.83718736	14.7312212	237.5076426	0.719667744	4.17990968	7.531511188	30.93043807	13.42638874	155.2888947	0.533967602	0.403858751	6.487445898	26.23023522	15.63158528	286.8230794	0.822146893	5.684367895	300.4051819
1982	Steelhead	0.740951621	0.676847222	0.500817057	135.42	141.1	146.67	0.019363231	969.6811823	50078.48	15.0366548	33.92299397	13.68856831	299.5032572	0.734867351	4.49458641	6.733218044	33.9510694	12.33396511	191.8316681	0.547297114	0.440103906	5.904563993	29.12319735	14.53213167	368.8361918	0.850430071	6.09023724	377.4519958
1983	Steelhead	0.731013848	0.670438061	0.489421259	135.52	142.07	148.45	0.017385991	850.8503979	48938.85	16.39222899	31.89833368	13.44313196	256.6496409	0.723013372	4.509415068	7.71544528	30.05448856	12.1761549	151.9720703	0.535399359	0.388565356	6.283063136	27.24813073	14.24484094	320.3638357	0.828616112	6.251318286	332.9926147
1984	Steelhead	0.699002598	0.652719571	0.455620493	135.86	144.01	149.88	0.016003437	729.1037973	45559.2	19.2422981	30.6585254	13.84742705	237.9419149	0.741179671	4.250168125	10.64659476	25.73604278	12.21579018	121.8152893	0.592313957	0.445548439	6.217608169	27.56215258	14.90876945	312.3347982	0.82296889	5.688201447	320.5012512
1985	Steelhead	0.710535643	0.63490329	0.450496435	135.59	143.35	148.79	0.01711328	770.9031157	45047.07	18.67768965	30.58878764	13.71152032	216.6986542	0.71549763	4.336790551	9.681175619	27.98951506	12.13251019	139.9483597	0.537500951	0.440705636	6.609181538	25.61971971	14.70731195	265.8312912	0.806007932	5.876859277	276.5330505
1986	Steelhead	0.721147425	0.637626141	0.459185643	135.54	142.97	149.17	0.016924388	777.0925621	45915.55	17.46967444	31.01185305	14.06503874	233.7017756	0.724670767	4.216070324	8.619395852	28.48314483	12.6595417	138.20242	0.543475336	0.463341796	6.463709526	26.2571657	14.95187759	292.4536184	0.82449763	5.743405884	300.9675598
1987	Steelhead	0.750679513	0.550263985	0.412500375	135.33	139.72	144.64	0.02091174	862.5521725	41247.27	15.12700646	32.47807718	15.5243639	208.9223562	0.712040205	4.228663848	5.868513331	35.40454175	13.86151657	181.3058197	0.51918247	0.630259055	6.863222905	24.25856391	16.63192272	230.676295	0.818739653	5.741620779	229.2389526
1988	Steelhead	0.702449375	0.612413892	0.429593772	135.63	143.4	149.6	0.016236624	697.4745388	42956.87	20.06561331	28.81735268	13.70780614	164.443222	0.702790309	4.143801331	10.43019301	25.9545001	12.12209339	118.243396	0.531230626	0.427644834	7.254292436	22.81352955	14.70694017	195.1779785	0.778047134	5.613316943	199.5900116
1989	Steelhead	0.738485079	0.627481333	0.462744092	135.38	140.76	146.64	0.018899674	874.5117172	46271.26	16.13368814	31.76857824	13.87858556	217.1845072	0.708216802	4.270717639	7.029603988	32.24941628	12.27888947	166.2161285	0.51252445	0.456833833	6.707317695	25.13088245	14.89594746	253.2895457	0.813011199	5.901429365	253.5335846
1990	Steelhead	0.743274223	0.553214538	0.410621143	135.44	141.63	147.68	0.01833977	753.0181274	41059.3	16.02811728	31.51089155	15.67593422	210.7418854	0.702816959	4.40928599	6.825356156	31.89211728	13.88217163	154.3601257	0.511717689	0.473591584	6.82343775	24.57884373	16.86535422	244.3662898	0.800174743	6.075740362	251.493103
1991	Steelhead	0.742997172	0.660003345	0.489702179	135.42	141.2	146.88	0.018991614	929.958937	48966.82	15.22308006	33.23256455	13.72925987	262.0229879	0.716479347	4.112098086	6.501721397	34.14704582	12.39393101	185.0493286	0.521981454	0.411086953	6.324467294	27.2106867	14.55128908	313.7264506	0.827601691	5.680706898	316.3543091
1992	Steelhead	0.740365465	0.532061553	0.393374736	135.43	141.37	146.81	0.01932067	759.979912	39335.07	16.82146145	30.52797981	15.6054395	174.2881358	0.69280993	4.134928586	7.271474868	30.78115092	13.86760559	139.9022736	0.505150369	0.431264538	7.166395091	23.09805375	16.77126408	198.2128245	0.777822723	5.685374588	198.6960144
1993	Steelhead	0.712727003	0.665414857	0.473602052	135.41	141.75	146.74	0.019293349	913.6838199	47357.45	18.06655061	31.27921958	13.03701706	251.6035411	0.734412141	4.167101574	9.458786458	28.12617954	11.40804882	161.7082336	0.569956714	0.486775398	6.209821828	27.35641647	14.04846684	315.3974457	0.823978235	5.684050242	317.2549438</

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Appendix E: Fish, Aquatic Macroinvertebrates, and Aquatic Habitat

Year	Specis	InRivSurvUC	InRivSurvLCol	InRivSurv	MedDayRIS	MedDayConfl	MedDayBON	SAR	TotalReturn	PassageBON	meanTravelTime	meanMigRate	meanTemp	meanFlow	meanFSpill	meanGas	UCTravelTime	UCMigRate	UCTemp	UCFlow	UCFSpill	UCGas	LCTravelTime	LCMigRate	LCTemp	LCFlow	LCFSpill	LCGas	BonFlow	
2004	Steelhead	0.721890417	0.616243954	0.444244697	135.45	142.51	148.8	0.017174416	762.9145192	44421.57	17.99081134	29.86324281	13.99496288	192.8227305	0.700998195	4.303131466	8.641666651	27.77984372	12.57358704	126.8832748	0.525809333	0.422015038	6.962275565	23.97533707	14.89889558	229.8485184	0.779692233	5.920351485	251.0012665	
2005	Steelhead	0.731549492	0.594921926	0.434612323	135.47	141.38	147.15	0.018570283	807.0373953	43458.54	17.17768193	30.58865616	14.9243618	195.5958761	0.706638314	4.106226292	8.028716207	29.09152757	13.57476673	132.1993149	0.532859114	0.447549477	6.765329674	24.65766508	15.85368649	239.6102575	0.787410607	5.558594371	242.3700562	
2006	Steelhead	0.735326798	0.678956307	0.498563999	135.45	141.89	146.61	0.0193908	966.6914684	49853.1	15.33726855	33.98101667	13.47080746	308.7493225	0.744450994	4.247679814	7.173473164	33.64359242	11.95785046	191.7543213	0.565873614	0.413738251	5.760585897	29.57525851	14.40510877	385.7539622	0.85645015	5.837027738	395.7884827	
2007	Steelhead	0.747779723	0.615823855	0.45986349	135.34	140.01	145.74	0.019810952	910.9729522	45983.3	15.10828108	32.81819547	14.72544028	229.3442912	0.712883611	4.153544927	6.13310428	34.90017443	13.35215702	182.3117188	0.523184109	0.447070861	6.582016438	25.50365528	15.63278659	262.9874064	0.817609082	5.685025116	265.585022	
2008	Steelhead	0.702054822	0.666283755	0.467119398	135.94	143.48	148.64	0.017431493	814.2057017	46708.89	18.74647374	31.79568027	13.94456889	290.6570236	0.757233891	4.146317365	10.51155639	27.33740901	12.3575613	159.4416901	0.601117721	0.474562633	5.852884233	29.11711823	14.98484453	374.070343	0.854770859	5.599941408	393.2251587	
—	Steelhead	0.729338361	0.639482685	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
MO3-RESSIM																														
1929	Steelhead	0.659057583	0.633081932	0.416658866	136.3	146.07	151.87	0.014170583	590.3949617	41663.42	24.46719176	27.20893961	14.02843107	158.7624425	0.816176353	2.897089416	14.96999985	20.46920942	12.3753828	92.03311615	0.666428262	0.651703322	7.132199883	23.16968894	15.1222078	201.2351227	0.943323116	2.379861698	210.9797668	
1930	Steelhead	0.695972715	0.547183856	0.380297021	135.81	144.35	149.73	0.016359018	622.0948626	38027.64	20.94596399	27.64134333	15.36672071	135.9479009	0.814733925	2.876894242	11.05320007	23.65268181	13.41258564	95.98946075	0.649769622	0.605591309	7.526816003	21.61045547	16.65978877	161.4322891	0.955562462	2.413587535	166.6564636	
1931	Steelhead	0.70313196	0.541480644	0.380204614	135.63	143.5	148.69	0.017411386	661.9528778	38018.39	20.40437647	27.71268925	15.30642535	133.9785843	0.811405513	2.813508876	10.44216359	24.25098038	13.42297745	100.0456711	0.641398814	0.501331741	7.589482546	21.37178938	16.56714233	156.2945201	0.954710325	2.3938943	160.3340302	
1932	Steelhead	0.737673203	0.688918976	0.507493725	135.38	141.03	146.39	0.01906943	967.6948287	50745.87	15.52565945	33.0065934	13.37273451	264.1188527	0.750471737	2.982259546	6.954154149	32.78264615	11.91963158	176.6412079	0.553013781	0.563421166	6.169353597	27.84446879	14.31756544	322.4273224	0.886255711	2.660070603	330.4920044	
1933	Steelhead	0.730490433	0.674434485	0.491986039	135.42	142.18	148.95	0.01715435	843.9145886	49195.37	16.81589132	31.36888047	13.86704191	239.2740997	0.769889948	3.619940042	7.81844151	30.16279261	12.46196804	153.4296661	0.573503417	0.838274872	6.609809101	25.76274636	14.75038131	287.6140849	0.91528373	3.365056445	304.7875061	
1934	Steelhead	0.758064737	0.590065337	0.446689368	135.32	139.36	144.27	0.02107	941.1088053	44665.82	13.55421252	34.95770354	15.46337821	251.6328247	0.767722354	3.121254933	4.666589677	40.79979306	13.77879276	218.8793915	0.575516218	0.98494699	6.484053127	26.05905498	16.58824412	273.7574717	0.915978869	2.724767456	277.6462097	
1935	Steelhead	0.727351405	0.664824667	0.482892102	135.49	142.21	148.35	0.017765419	857.8269064	48286.33	17.34038726	30.82756961	13.87022985	213.4753347	0.774825623	2.684872894	8.199028105	29.44406553	12.48313217	147.6493134	0.574865296	0.508339036	6.752936304	25.01764072	14.7513531	253.4676005	0.925393343	2.024189375	265.1940918	
1936	Steelhead	0.734989575	0.631931997	0.463820567	135.4	141.39	146.17	0.020016608	928.3524619	46379.11	16.13724359	32.36699354	14.18268172	244.4787516	0.757842443	2.871329317	7.432552278	31.89643526	12.35145283	166.1085266	0.555994603	0.491428858	6.305112317	26.95438904	15.36388954	296.0045522	0.901339342	2.540795396	302.9780273	
1937	Steelhead	0.686771814	0.65180827	0.447022892	135.88	144.18	150.8	0.015184619	678.7472885	44699.66	21.56600379	28.17215619	13.66584517	163.9129985	0.806808588	2.873248523	12.01053557	23.62083495	12.21938057	106.6464722	0.634270829	0.541923201	7.180654697	23.06974911	14.65122302	200.0593643	0.949352751	2.392344331	209.5236816	
1938	Steelhead	0.737261958	0.67131619	0.494250998	135.44	141.49	147.53	0.018140834	896.5496091	49421.63	15.85965739	32.33695845	13.83013109	249.1477905	0.759005296	2.88822482	7.11491552	31.78231796	12.25704346	161.1415131	0.559956163	0.565238798	6.348879531	26.93041338	14.82115173	302.7968089	0.900503933	2.487783323	315.530365	
1939	Steelhead	0.708963229	0.587634065	0.416034022	135.52	143.09	147.64	0.018417944	766.2068986	41601.11	19.40073425	29.35800463	14.19713771	174.4323802	0.790140883	2.822391093	9.920354337	27.10643664	12.0992281	129.7131409	0.590796953	0.495543128	7.091981262	23.29227417	15.58700625	204.1676102	0.94806385	2.348642771	207.6969757	
1940	Steelhead	0.729807224	0.597453432	0.43542198	135.5	142.3	147.35	0.018861294	821.2122521	43539.55	17.30261347	30.43961704	14.84521605	193.5569702	0.783542318	2.940563498	8.058974952	29.05627584	13.0926609	135.7818268	0.58									

Columbia River System Operations Environmental Impact Statement
Appendix E: Fish, Aquatic Macroinvertebrates, and Aquatic Habitat

Year	Specis	InRivSurvUC	InRivSurvLCol	InRivSurv	MedDayRIS	MedDayConfl	MedDayBON	SAR	TotalReturn	PassageBON	meanTravelTime	meanMigRate	meanTemp	meanFlow	meanFSpill	meanGas	UCTravelTime	UCMigRate	UCTemp	UCFlow	UCFSpill	UCGas	LCTravelTime	LCMigRate	LCTemp	LCFlow	LCFSpill	LCGas	BonFlow
1959	Steelhead	0.745917666	0.682801684	0.508609103	135.4	140.87	147.04	0.018804478	956.3487246	50857.5	15.0004091	33.22244284	13.74349569	258.7571035	0.758416117	4.148807255	6.208109513	34.57827439	12.37353897	187.731076	0.559097412	0.681368661	6.393219039	26.85175533	14.59670305	303.000824	0.903062811	4.388695459	313.9589844
1960	Steelhead	0.731028943	0.683918609	0.499272349	135.35	141.18	147.58	0.018063251	901.7900819	49924.02	16.63633941	31.73316627	13.31759097	232.5371002	0.765685529	2.944762033	7.64342922	31.43517093	11.81726398	168.0256378	0.562695181	0.527009118	6.598080866	25.69789633	14.29138549	273.842219	0.915932159	2.57668451	282.723175
1961	Steelhead	0.745154706	0.693787317	0.516263438	135.38	141.06	147.01	0.019113799	986.7099033	51622.91	14.9388992	33.71297155	13.37213904	287.6548096	0.756341323	2.964309126	6.302388787	34.83901814	12.195257	200.0629883	0.567828822	0.536372101	6.232371442	27.91986799	14.13816643	338.4040426	0.888533374	2.680940196	353.4532166
1962	Steelhead	0.731323005	0.666463634	0.486725871	135.48	142.11	148.15	0.017811652	866.882616	48669.41	16.67216825	31.71395884	13.87280032	231.3593577	0.765129048	3.10155528	7.720288754	30.8733796	12.26765957	157.0432861	0.563204789	0.561236024	6.562292054	26.0564883	14.88068295	277.24646	0.912398666	2.79176718	285.9081726
1963	Steelhead	0.709566216	0.665009676	0.471214485	135.85	143.7	149.33	0.016725003	788.059918	47118.67	18.67045692	30.26993329	13.9896944	217.9426707	0.780064414	2.821009346	9.727276087	26.59939589	12.61389599	129.8708801	0.605400178	0.564526498	6.561164416	25.91783458	14.85873286	273.9738057	0.909317752	2.273872435	283.7628479
1964	Steelhead	0.711298882	0.679935821	0.482967608	135.58	142.86	148.86	0.017129875	827.2684637	48293.9	18.28843768	31.49659766	13.830826	261.2105062	0.767253453	3.086011503	9.664615422	28.32714398	12.21846924	157.6603455	0.589999706	0.588522834	6.242631055	27.53492553	14.8761495	324.502538	0.89322107	2.661513587	338.5744934
1965	Steelhead	0.739987294	0.698001723	0.515797606	135.4	141.3	147.4	0.018426639	950.378422	51576.33	15.50947692	32.96986924	13.31967824	267.2823995	0.750060563	3.020659335	6.953499049	32.39934877	12.07212601	169.6613586	0.553026667	0.559680116	6.154594511	28.06291161	14.12446435	329.0570068	0.884962221	2.697662224	337.5050049
1966	Steelhead	0.722849401	0.59934181	0.432633884	135.44	142.4	147.87	0.018394037	795.745905	43261.08	18.07585591	30.22933929	14.63986066	192.2164602	0.780920082	2.850959229	8.708226889	28.99374253	12.6318697	146.0906281	0.572943154	0.529735816	6.984734245	23.83250738	15.92576504	221.5747808	0.942431599	2.41366004	227.5129242
1967	Steelhead	0.715231547	0.702297255	0.501609913	135.47	142.78	148.08	0.017995675	902.6297813	50158.15	17.61326947	32.38431539	12.97162685	281.8035695	0.756189414	2.945052109	9.061466545	30.41748805	11.31825657	181.6372192	0.572210526	0.538550454	6.157534592	28.16701734	13.98171759	343.6058502	0.882633845	2.459925234	356.3138733
1968	Steelhead	0.716103931	0.630800686	0.451093177	135.65	142.7	149.14	0.01684878	759.9930318	45106.71	18.5335596	30.09923869	14.87036432	207.6621358	0.785761584	3.201180077	9.400010943	27.30885842	13.4987484	137.6746155	0.604933256	0.572891307	6.759681098	24.80291557	15.85360257	249.5930023	0.925309141	2.816584845	262.993042
1969	Steelhead	0.749946372	0.688244502	0.51543238	135.32	140.03	145.24	0.020631174	1063.32782	51539.86	13.77868428	35.49007541	13.73290634	315.9557404	0.74102203	2.989326378	5.598641738	37.3942286	12.41976891	215.0582886	0.563284197	0.574338686	5.7705101	30.2962256	14.55876525	382.5615997	0.856779834	2.678171098	388.1356812
1970	Steelhead	0.689583271	0.699963737	0.482014141	136	144.22	149.83	0.016084978	775.2687388	48198.31	20.44148853	30.14585671	12.96106186	241.4078618	0.773276716	2.855479217	11.75495192	24.66451558	11.74934998	131.4017075	0.608194745	0.510021925	6.299471095	27.27948996	13.74966637	311.4424947	0.889518311	2.398235261	321.9587402
1971	Steelhead	0.748413747	0.711795717	0.531981539	135.29	139.6	145.03	0.020565919	1093.996472	53194.63	13.42750364	36.23190038	13.13463739	337.8972921	0.740839362	3.161488187	5.386730164	38.621653	11.67841625	233.6761719	0.572943023	0.865999603	5.625920482	31.18949298	14.02495432	406.9010264	0.849710286	2.828205297	411.2102356
1972	Steelhead	0.756664425	0.709089306	0.535801206	135.29	139.58	144.6	0.02108786	1129.812683	53576.45	12.853543	37.75354767	13.55789541	368.4647878	0.748305646	3.155808461	4.979773313	41.70001207	12.29609585	253.4012787	0.587019214	0.671309185	5.460387975	32.41156129	14.36237653	443.7544912	0.850358576	2.919839114	448.4985657
1973	Steelhead	0.706980952	0.664404567	0.469070435	135.76	142.65	149.04	0.016864558	791.0187593	46904.21	19.55961518	28.9596189	13.53365568	178.9124125	0.794495864	3.004520661	10.11342391	25.52090848	12.32918262	124.525882	0.609251019	0.605429012	7.061008967	23.57827991	14.3359917	215.9963608	0.941115061	2.573406051	221.0992889
1974	Steelhead	0.754462205	0.699077806	0.526698669	135.31	139.46	145.47	0.019914695	1048.831902	52666.23	13.07130072	36.43816814	13.61732979	327.0963053	0.748601485	3.279171928	4.87775372	40.55618292	12.26302929	240.841449	0.577715138	1.216146636	5.782225601	30.05240604	14.45706908	383.3356323	0.864136696	2.826637665	387.0356445
1975	Steelhead	0.725843066	0.702209641	0.508988329	135.43	141.48	147.88	0.017924783	912.2986684	50895.94	16.83885778	32.30038569	13.15508194	260.172347	0.75811885	3.47553978	8.187282115	31.05672319	11.82584839	167.8819458	0.566308856	0.631957138	6.25746429	27.42270884	14.03130802	319.5962931	0.893031567	3.24073419	327.4905701
1976	Steelhead	0.735531813	0.717778798	0.527219305	135.31	140.4	145.73	0.019911038	1049.685656	52718.78	15.1076228	34.24784918	12.78945268	300.2443695	0.742677924	3.157660532	6.874405816	34.28354543	11.38303051	201.8880066	0.561871502	0.583889008	5.825006686	29.7672054	13.67112176	368.9265798	0.861879279	2.927598258	368.9979248
1977	Steelhead	0.702583843	0.599944752	0.420927065	135.66	142.92	150.59	0.01548123	651.6097682	42090.31	20.70728397	27.19749643	14.50606842	123.6763494	0.812363869	3.036649652	10.47989818	23.68559825	13.31655045	96.40558014	0.648402238	0.730915326	7.855340719	20.54608595	15.42045625	140.5800578	0.950605204	2.526982461	146.1307526
1978	Steelhead	0.734809646	0.680245743	0.499159541	135.4	141.61	147.37	0.018461189	921.449615	49912.8	16.31957798	31.7098133	13.43744691	228.5470174	0.767427512	3.056254133	7.328326404	31.52658383	11.92678967	164.8946228	0.562428537	0.54019388	6.592974871	25.60387143	14.36460797	269.9070384	0.919650227	2.683716158	277.4730835
1979	Steelhead	0.717125502	0.683171753	0.489241447	135.49	142.4	148.02	0.017988425	880.0187305	48921.39	18.11007987	30.413129	13.13465424	214.9639231	0.774489926	2.826512791	9.071240395	27.78181314	11.7568203	141.0972717	0.580202609	0.563405961	6.642864905	25.45553541	14.02791897	263.3015594	0.918371409	2.279870418	271.4862061
1980	Steelhead	0.744066955	0.69561024	0.516864781	135.32	139.77	145.69	0.019895348	1028.254671	51683.17	14.56777331	33.76690565	13.31595402	277.5517802	0.754314473	3.106868074	6.029031053	34.94176048	12.01130199	206.8199951	0.571395043	0.833238685	6.130630426	28.01544897	14.16571951	325.6025085	0.881902675	2.709441846	329.463501
1981	Steelhead	0.732998226	0.643387373	0.470948966	135.48	142	148.05	0.018038578	849.4736244	47092.05	16.51525065	31.67886372	14.79262778	237.3135091	0.768900449	2.924011002	7.659165144	30.34706026	13.45781631	154.183075	0.582354081	0.529899043	6.474041328	26.31795083	15.73269876	287.2944539	0.904750387	2.48744609	300.8244019
1982	Steelhead	0.738519695	0.694808723	0.512420269	135.42	141.2	146.66	0.019421357	995.1254904	51238.72	15.2143878	33.97694601	13.66399231	299.1387685	0.749416562	3.167450313	6.921356037	33.48330744	12.35022984	189.8943024	0.569031584	0.593511641	5.893837482	29.65165096	14.48591614	369.1971436	0.8695485	2.818046967	378.2512817
1983	Steelhead	0.727932614	0.698249573	0.50757513	135.53	142.21	148.51	0.017360534	881.1177652	50754.07	16.62392998	31.77838965	13.34181951	254.1135864	0.76277649	3.245322017	7.933797956	29.52295875	12.12091522	149.3430664	0.575550187	0.548333812	6.295555413	27.40117919	14.11563762	317.9132385	0.895070344	3.049736232	330.3638916
1984	Steelhead	0.696048316	0.675257555	0.469360355	135.9	144.23	149.99	0.015946631	748.4240122	46933.05	19.60991647	30.52415408	13.8750658	235.9401484	0.776756395	2.978547714	11.00623021	25.29944046	12.24574108	119.2087448	0.613165623	0.561519617	6.226125553	27.58359905	14.94083738	310.6559906	0.894554585	2.540404618	318.9031982
1985	Steelhead	0.710290288	0.666428436	0.472702189	135.59	143.27	148.69	0.017209893	813.4672587	47267.42	18.72633135	30.56781359	13.63509668	217.2749359	0.776440152	3.080680941	9.729520917	27.9082911	12.10085831	139.5709991	0.589092836	0.570681691	6.608628713	25.64496706	14.59462452	266.8219274	0.915390025	2.694044764	277.7381897
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Appendix E: Fish, Aquatic Macroinvertebrates, and Aquatic Habitat

Year	Specis	InRivSurvUC	InRivSurvLCol	InRivSurv	MedDayRIS	MedDayConfl	MedDayBON	SAR	TotalReturn	PassageBON	meanTravelTime	meanMigRate	meanTemp	meanFlow	meanFSpill	meanGas	UCTravelTime	UCMigRate	UCTemp	UCFlow	UCFSpill	UCGas	LCTravelTime	LCMigRate	LCTemp	LCFlow	LCFSpill	LCGas	BonFlow	
1996	Steelhead	0.746221109	0.674396926	0.502553079	135.45	141.15	146.84	0.018556618	932.5053277	50251.9	14.64955405	33.73164799	14.12198989	278.0857005	0.748625379	3.06863537	6.205830038	34.14461717	12.80324707	179.3740692	0.556501883	0.683304375	6.046420425	28.46545005	15.05318912	340.295934	0.879963607	2.761405418	351.6931152	
1997	Steelhead	0.760840636	0.714588564	0.542936806	135.29	139.22	143.86	0.02138497	1160.988519	54289.93	12.0546625	39.10280723	13.59902509	400.9502736	0.747440373	3.939654843	4.477451727	43.5137352	12.28275089	276.1547791	0.596537149	1.277442729	5.159480684	34.32339318	14.41243951	484.7032013	0.83936429	3.606915842	489.2528687	
1998	Steelhead	0.741811571	0.681523523	0.50486244	135.37	140.8	146.64	0.019380487	978.3862859	50483.06	15.06289735	33.48989669	13.83867137	274.1713684	0.748012559	2.902549587	6.593193993	33.48671288	12.49887447	178.5067444	0.556464303	0.494840223	6.06830591	28.45719974	14.6900986	336.0892487	0.87794892	2.571889679	343.0171204	
1999	Steelhead	0.737410152	0.683027396	0.502974508	135.51	141.82	147.92	0.017696038	890.0039927	50293.97	15.79589887	32.33994542	13.76452026	257.2145528	0.759159103	3.352688046	7.065990061	31.51274243	12.42900944	161.7651428	0.564562258	0.758113849	6.334986903	27.1511286	14.58310795	314.2059733	0.89709873	3.16990761	328.815033	
2000	Steelhead	0.737157606	0.613370177	0.451524807	135.46	142.04	147.17	0.018668183	842.8587452	45149.48	16.38442862	31.30333485	14.64851589	210.3121562	0.775153441	3.004134985	7.26050064	30.99903403	12.86654453	149.8506012	0.569612333	0.570785975	6.732377581	24.94871498	15.78295088	248.1405869	0.931348632	2.792479326	257.69104	
2001	Steelhead	0.69240139	0.622565873	0.430467633	135.81	144	150.13	0.015887652	683.8757067	43044.48	21.25280198	27.55072165	14.18505274	142.6381673	0.812718193	2.820248376	11.41533744	23.14972624	12.79079838	99.08732452	0.64768616	0.607839268	7.4633075	21.90067834	15.08083169	171.7384135	0.95174551	2.260558856	177.4883575	
2002	Steelhead	0.730011683	0.669999497	0.48843039	135.5	142.42	148.39	0.017707227	864.8165556	48839.75	16.48150603	32.09948266	13.86091938	249.7948741	0.764574804	2.878424819	7.643990278	31.55146346	12.25130615	170.070517	0.571683028	0.551808333	6.447459713	26.46079849	14.87043699	296.8959503	0.905102591	2.492437104	311.3011475	
2003	Steelhead	0.722531516	0.67707872	0.488533697	135.54	142.89	149.18	0.017018204	831.3420011	48850.16	17.40969069	30.83665359	13.47983239	232.4613363	0.773923815	2.916867822	8.394708306	28.82565337	12.260429	143.769632	0.588307011	0.575215435	6.621263586	25.61794482	14.2831955	281.9601746	0.911500682	2.415293659	305.0435181	
2004	Steelhead	0.718014311	0.651260388	0.466966588	135.45	142.75	149	0.016985243	793.1033387	46693.67	18.34268968	29.59490258	13.9661272	189.3726008	0.790812052	2.947703681	8.963675112	27.12354324	12.59206333	122.5420593	0.602017492	0.54588632	6.992667429	23.8451613	14.84112453	226.8299281	0.940108558	2.503063947	248.1354523	
2005	Steelhead	0.728899203	0.620607613	0.451733921	135.49	141.57	147.46	0.01830004	826.6225011	45170.53	17.43974721	30.32517452	14.95534356	191.3225972	0.785958501	2.719410289	8.264941216	28.43575147	13.59353828	127.5070923	0.594742486	0.472146815	6.792682327	24.52746724	15.90807199	235.3639501	0.933601369	2.11877771	238.1486511	
2006	Steelhead	0.732488919	0.696433027	0.50942356	135.49	142	146.64	0.019306926	983.4758771	50939.02	15.52313697	34.05161664	13.40375862	307.5854045	0.74752159	2.73980299	7.37207149	33.08516909	11.93321323	189.8729309	0.569411331	0.448886853	5.747603372	30.22005462	14.30530516	385.3170522	0.863928924	2.166742404	395.3374023	
2007	Steelhead	0.747142648	0.63589627	0.474448011	135.34	140.19	146.1	0.019348117	917.9085381	47441.75	15.30475132	32.44427439	14.77182426	222.0673065	0.769249163	2.980013263	6.270077929	34.09462956	13.37966099	175.2225006	0.561900407	0.571236372	6.643467642	25.2171676	15.70962381	255.3961182	0.925449024	2.714322001	258.1043396	
2008	Steelhead	0.700559575	0.681122601	0.476505655	136.1	143.53	148.6	0.017457791	831.8208139	47647.54	18.90798225	31.85511479	13.94146322	287.5315018	0.764026251	2.898747563	10.66433182	27.00304134	12.37459469	157.6786209	0.60863333	0.596547562	5.861279331	29.54836297	14.97111352	370.2283122	0.868043373	2.390946721	389.0479431	
-	-	0.72676091	0.662138378	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
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1929	Steelhead	0.698128981	0.640066474	0.445614493	135.76	143.85	149.79	0.016234432	723.3811112	44558.45	20.59108986	27.55485277	13.8632295	177.9991343	0.808428391	11.03249541	10.81263384	23.8692547	12.28033314	116.9261551	0.613397521	0.964555335	7.244391263	22.48203148	14.89401356	216.1449025	0.972745915	16.95736313	225.5170288	
1930	Steelhead	0.722403669	0.56480066	0.406887382	135.61	142.42	148.01	0.018024148	733.3333658	40686.16	18.80367666	27.78335829	15.09825548	155.8020533	0.80263332	9.596471081	8.691886276	26.10903482	13.24160805	121.0412628	0.603998512	0.630567437	7.578902632	21.17479755	16.27722247	179.1240514	0.967007538	14.87052194	182.4289093	
1931	Steelhead	0.727567535	0.56197131	0.407742942	135.54	141.99	147.34	0.018934249	771.9796463	40771.6	18.37247173	28.01683309	15.08083382	161.2053416	0.798769056	9.749495359	8.291787356	26.75122812	13.28773975	129.1963409	0.594354793	0.720927298	7.541466981	21.29281479	16.239772	183.0805283	0.966232985	15.06757029	186.3124542	
1932	Steelhead	0.734759658	0.685244999	0.502100247	135.48	141.25	146.74	0.018783284	943.0431436	50206.51	16.11907099	31.26740883	13.49691804	262.2636851	0.78248582	13.28729224	7.180642277	30.94639376	12.02007236	175.0967346	0.563234851	1.913717365	6.383938164	26.08894						

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Year	Specis	InRivSurvUC	InRivSurvLCol	InRivSurv	MedDayRIS	MedDayConfl	MedDayBON	SAR	TotalReturn	PassageBON	meanTravelTime	meanMigRate	meanTemp	meanFlow	meanFSpill	meanGas	UCTravelTime	UCMigRate	UCTemp	UCFlow	UCFSpill	UCGas	LCTravelTime	LCMigRate	LCTemp	LCFlow	LCFSpill	LCGas	BonFlow
1951	Steelhead	0.748886925	0.683358201	0.510345624	135.42	140.05	145.55	0.020076473	1024.522899	51031.02	14.45889318	32.81343872	13.78656413	287.0929494	0.781281629	13.94137479	5.6017268	35.12950864	12.42499218	206.4741852	0.573783481	3.405381536	6.296077371	26.53944005	14.63278341	338.6734111	0.948716203	20.29414805	351.306488
1952	Steelhead	0.738475987	0.70051105	0.515882712	135.43	140.81	146.07	0.019714259	1016.954902	51584.74	15.28353754	32.26135661	13.23690529	294.6308014	0.776419241	14.45767833	6.616009086	32.53869293	11.71920757	193.36539	0.570062247	3.742035055	6.105414227	27.32902453	14.17156235	360.6554464	0.938853343	21.14492337	370.6419067
1953	Steelhead	0.732756152	0.698040802	0.510081206	135.5	141.48	148.29	0.017758248	905.7553442	51004.77	16.79417746	30.30541485	13.24550559	248.1901499	0.786527354	12.75921468	7.577232152	29.34095569	12.12015724	166.1227844	0.568238133	1.616207385	6.667140633	24.97070452	13.9731981	297.5423228	0.962375522	19.42183828	311.8495789
1954	Steelhead	0.726145227	0.711475151	0.515207965	135.5	141.55	147.17	0.018601899	958.3231415	51517.49	16.71792288	31.46076194	13.00191994	282.9551849	0.7839008	14.10338321	7.880743444	30.92005884	11.57340889	194.493811	0.580585781	3.67187171	6.284130633	26.5782694	13.90045706	341.5654399	0.94745785	20.46432718	353.2147522
1955	Steelhead	0.714759915	0.68896007	0.491080676	135.65	142.64	149.44	0.016405139	805.5710507	49104.8	18.59922573	29.26725325	13.2606741	228.8439412	0.794423643	12.29604283	9.257254004	26.84464317	11.89072571	148.6799805	0.583843443	1.245749831	6.802777424	24.33981134	14.16774877	277.273969	0.966196428	18.88580561	291.9988403
1956	Steelhead	0.746986723	0.71447451	0.532229956	135.45	140.73	145.76	0.019724166	1049.706332	53219.3	14.03712666	33.83429955	13.14574706	356.1292124	0.768887925	15.61234115	5.682426006	35.57992376	11.64327679	228.218399	0.575862503	4.37845583	5.787379265	28.78274959	14.05963039	433.9367421	0.914476782	21.99207671	456.319397
1957	Steelhead	0.740181187	0.715714177	0.528295881	135.4	140.37	145.32	0.020730116	1095.092829	52826.18	14.64424619	33.50198252	13.05513763	352.4061483	0.767542854	16.16629985	6.371837914	34.23946018	11.71244011	223.0259186	0.580785158	5.909860039	5.703836724	29.08233772	13.91692305	436.233551	0.905765692	22.12305832	449.425354
1958	Steelhead	0.730655632	0.692444279	0.504541218	135.49	141.64	146.79	0.019304385	973.9224543	50450.84	16.20313603	31.7649195	13.50528692	305.4981842	0.774447725	14.08498159	7.614749014	30.50606676	11.98721523	182.5317444	0.571236494	2.314404082	6.03273648	27.71193602	14.45745532	381.8606669	0.92965891	21.22196547	399.1619568
1959	Steelhead	0.744441313	0.677628716	0.503061914	135.49	141.04	147.31	0.018562111	933.7263507	50302.81	15.42586549	31.60533316	13.84768162	259.6167837	0.783313915	12.78118722	6.28066653	32.89863762	12.48299904	188.3138489	0.562435892	1.486561871	6.592865765	25.2835129	14.69758431	303.877594	0.962608596	19.55711508	314.8978882
1960	Steelhead	0.729476895	0.676843069	0.492377966	135.45	141.36	147.92	0.017742452	873.5421592	49234.58	17.07453001	30.25213292	13.4283247	232.6569356	0.788151368	12.13487596	7.726840466	29.96366989	11.90106087	168.1025452	0.566889128	1.021143806	6.800039575	24.2953984	14.42775838	273.848175	0.968600621	18.82277282	282.7469788
1961	Steelhead	0.743414936	0.689367225	0.511071075	135.48	141.23	147.3	0.018830298	962.2960023	51103.6	15.40536594	31.91695454	13.5168986	288.3742015	0.779621951	13.44442854	6.411956042	33.01762496	12.31744308	200.0280823	0.571799883	2.765297985	6.436430976	26.01361885	14.30211957	339.459142	0.943334202	19.62439712	354.6586609
1962	Steelhead	0.729885598	0.659835344	0.480274319	135.55	142.24	148.41	0.017551592	842.90171	48024.23	17.10571057	30.2094761	13.9434562	231.8793427	0.787994993	12.27281923	7.803542197	29.36049439	12.29453888	157.5801819	0.565488967	1.239443767	6.759219915	24.64043907	14.99066178	277.6894124	0.967758755	18.89107466	286.3416748
1963	Steelhead	0.726780443	0.663807827	0.481110478	135.56	142.51	148.41	0.017676856	850.3960865	48107.88	17.47312918	29.76316908	14.02188638	226.3801493	0.793771711	12.19521246	8.192218691	28.00318887	12.66640987	144.3253876	0.579451579	0.841884124	6.738024384	24.65481502	14.88069932	277.8931122	0.968068868	19.10705956	286.9694519
1964	Steelhead	0.710530222	0.674797394	0.47813957	135.66	143.06	149.21	0.016782667	802.3934257	47810.84	18.67215291	29.93943298	13.92654285	259.7376526	0.791420774	12.96943625	9.675155699	27.12773326	12.30512638	156.3730621	0.592786691	1.491379356	6.462698847	25.73065717	14.98408667	322.5801341	0.951155851	19.90352821	336.6481934
1965	Steelhead	0.738249031	0.694736422	0.511472203	135.5	141.5	147.72	0.018152408	928.3829621	51143.79	15.98827094	31.2531439	13.45547237	266.8571594	0.779887992	13.11123867	7.069221616	30.68639467	12.18695354	168.9552612	0.559005958	1.232291269	6.364842087	26.26675397	14.27839088	328.6368917	0.954472462	20.49069627	337.1407776
1966	Steelhead	0.729818972	0.603444438	0.439189243	135.54	142.01	147.51	0.018689216	820.7565444	43916.05	17.61049505	29.57072443	14.54364319	204.1556091	0.789732299	11.28684314	7.994600385	29.24677475	12.5515152	158.1491394	0.561762834	0.784765971	7.075049236	23.11564661	15.78077809	233.8253632	0.975129217	17.49415795	239.7819824
1967	Steelhead	0.713349019	0.699028199	0.497273909	135.57	143.01	148.49	0.017567894	873.546856	49724.05	18.15441801	30.5772394	13.09582361	278.1501587	0.783095135	13.27233609	9.218763024	28.69499455	11.4279501	178.3454956	0.578353232	2.089419222	6.389111564	26.1531558	14.12180249	339.6852468	0.944009066	19.97621854	352.0823059
1968	Steelhead	0.73216933	0.629716726	0.459785785	135.54	141.68	148.24	0.017791015	817.952036	45975.57	17.35256691	29.67187998	14.79481144	215.2120372	0.793017379	11.72959103	7.866644204	28.89170693	13.42649994	153.4249329	0.57523545	1.036120605	6.950484574	23.60482575	15.73658069	252.0759633	0.971197695	18.01099586	263.6241455
1969	Steelhead	0.74749486	0.686952938	0.512076345	135.42	140.27	145.59	0.020347979	1041.899943	51204.1	14.34815241	33.30271405	13.83092569	313.8797841	0.772595555	14.38955816	5.780931622	35.12570706	12.48785896	212.9632416	0.572367033	3.567280006	6.004763618	27.78046524	14.6833477	380.5513611	0.928008586	21.01359431	386.0590515
1970	Steelhead	0.705022706	0.699827659	0.492031342	135.63	143.51	149.34	0.016722319	822.7348945	49199.81	19.18238544	29.34457068	13.02019806	246.6707738	0.793473375	12.71706239	10.12529659	25.61980216	11.74191608	142.0054443	0.592763019	1.073986459	6.511421755	25.62435434	13.84836976	312.5933533	0.955183307	19.88505332	322.4967957
1971	Steelhead	0.746387026	0.712127468	0.530055704	135.4	139.81	145.33	0.02033809	1077.958822	53001.97	13.93269527	33.97682268	13.21560955	337.5665476	0.771116253	16.27790909	5.507953674	36.40299234	11.76167164	233.3214233	0.579748398	6.989266014	5.856709674	28.46090205	14.10817337	406.5208079	0.919767698	21.80170043	410.8690186
1972	Steelhead	0.754473961	0.706353308	0.531454202	135.39	139.78	144.93	0.020776092	1104.077271	53141.72	13.37661225	35.08397754	13.66424224	368.4883392	0.771632466	16.06480926	5.112996593	38.86898293	12.38502293	253.3319153	0.589296928	5.490853786	5.697322592	29.15544154	14.48129193	443.9643606	0.906765362	22.20111465	448.5415955
1973	Steelhead	0.724772929	0.658010436	0.475590791	135.55	141.94	148.47	0.017585306	836.284328	47555.86	18.19877423	28.65145496	13.64637375	190.2452784	0.796336195	11.15912096	8.447443783	27.09221427	12.4151886	139.9924377	0.57999531	1.017006171	7.205948994	22.66180751	14.46947336	223.8010712	0.973126719	17.15961734	228.6638641
1974	Steelhead	0.753207976	0.698536102	0.524691128	135.4	139.63	145.7	0.019744082	1035.881935	52465.44	13.49772184	34.37730831	13.70725562	329.1098999	0.77888417	17.08069054	4.940509126	38.3979876	12.36092911	242.8283875	0.586818567	9.220161152	5.992088601	27.76881311	14.54274718	385.1587219	0.931554089	21.69923671	388.9115601
1975	Steelhead	0.724247151	0.697968959	0.504105887	135.53	141.65	148.22	0.017592742	886.80247	50407.29	17.28035738	30.67903152	13.24749921	260.4622416	0.784217222	12.9656999	8.269531816	29.53235123	11.86573009	167.9088379	0.571236429	1.443996954	6.463973999	25.71322597	14.16237434	319.7939097	0.954161396	20.01147262	327.7306519
1976	Steelhead	0.734126177	0.718115163	0.525732001	135.41	140.61	146.07	0.019590489	1029.866502	52569.72	15.56653668	32.26467171	12.87991714	297.4827718	0.775587198	14.44634813	6.942404211	32.41972012	11.45532265	200.0063751	0.570012668	3.686416531	6.062822089	27.42771158	13.77725538	365.77565	0.937151452	21.19230286	365.5746155
1977	Steelhead	0.723862496	0.603935261	0.435958417	135.55	141.51	148.68	0.01721187	750.3182461	43593.07	18.94291067	27.41211019	14.52875741	147.3503998	0.798998491	9.062950087	8.594085723	25.95529867	13.30327702	125.0999649	0.599447882	0.779061651	7.812492728	20.41210092	15.43458525	162.9597778	0.961794257	13.83667437	

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Appendix E: Fish, Aquatic Macroinvertebrates, and Aquatic Habitat

Year	Specis	InRivSurvUC	InRivSurvLCol	InRivSurv	MedDayRIS	MedDayConfl	MedDayBON	SAR	TotalReturn	PassageBON	meanTravelTime	meanMigRate	meanTemp	meanFlow	meanFSpill	meanGas	UCTravelTime	UCMigRate	UCTemp	UCFlow	UCFSpill	UCGas	LCTravelTime	LCMigRate	LCTemp	LCFlow	LCFSpill	LCGas	BonFlow
1988	Steelhead	0.718664082	0.65086724	0.466463252	135.55	142.65	148.86	0.017163553	800.565075	46643.32	18.70737523	28.63008765	13.5848313	184.6131571	0.795154237	10.74613908	8.879686207	27.33773761	12.02295895	138.2302948	0.577565554	0.773078501	7.284069434	22.38478919	14.56227207	215.2744573	0.973152975	16.62907592	220.0105286
1989	Steelhead	0.734850936	0.6452712	0.472868801	135.48	141.01	147.12	0.018450156	872.3905521	47283.64	16.81635672	30.02346863	13.94604041	212.0334819	0.790231101	11.5335128	7.302149922	30.17562877	12.33516235	162.4047607	0.567822299	0.857830441	6.964903042	23.56531693	14.98297071	247.2591756	0.971873293	18.05099916	247.2663116
1990	Steelhead	0.747511556	0.580412949	0.432667487	135.49	140.89	146.77	0.019085672	825.7190847	43263.82	15.88015331	30.79414961	15.62078355	220.9737152	0.786171526	11.62492617	6.430721343	32.06460217	13.83264217	169.0753296	0.558700922	1.049251068	6.912042394	23.78842219	16.78368807	253.3344447	0.970991015	17.8822879	258.121521
1991	Steelhead	0.740626469	0.680609134	0.502685588	135.51	141.37	147.1	0.018804493	945.2082348	50265.02	15.74862896	31.49099503	13.82071902	259.9704631	0.782868567	12.78823978	6.652626872	32.17308519	12.51145458	183.757135	0.567754087	1.970021105	6.545175985	25.58594495	14.63171164	311.2974243	0.955767006	19.29352164	313.6676636
1992	Steelhead	0.743029391	0.563768194	0.417739642	135.5	141.05	146.55	0.019612391	819.2324989	41771.17	16.67340133	29.91368959	15.60085011	193.928124	0.79102607	10.81712873	6.96365118	30.71253267	13.85407124	156.7585358	0.56703999	0.808972359	7.169944957	22.74035781	16.75077597	219.4615453	0.973536372	16.73410018	220.9672546
1993	Steelhead	0.714143784	0.688221559	0.490131609	135.48	141.69	146.81	0.019165687	939.3081882	49009.89	18.05211012	30.13461892	13.03308144	255.513503	0.790203427	12.84226423	9.106288165	27.74079514	11.39965763	166.1320953	0.590105015	1.328088307	6.392098695	25.91931566	14.04700136	318.9117839	0.951208889	20.05723381	320.4338074
1994	Steelhead	0.734796763	0.579563561	0.424685628	135.56	141.92	147.24	0.018996376	806.6947686	42465.72	17.41075118	29.13940122	14.97495295	185.7713959	0.792841149	10.69683076	7.631686836	28.7642345	13.15657177	143.5510529	0.57187289	0.743267059	7.236458153	22.45879601	16.13268948	214.0204112	0.972360661	16.58059434	217.8973389
1995	Steelhead	0.726831642	0.683349168	0.495307972	135.61	142	148.45	0.017531853	868.3100805	49527.57	17.39811425	29.8784628	13.54730848	231.1090139	0.793329702	12.40669243	8.168497741	28.15306078	12.30153999	148.9616119	0.57674472	0.800182104	6.683188394	24.85653525	14.35759846	283.8363495	0.969600548	19.55689724	292.8260498
1996	Steelhead	0.744726248	0.67570002	0.501822328	135.54	141.28	147.08	0.018384249	922.4964065	50178.63	15.10811055	31.98009647	14.1362772	277.6471202	0.779379629	13.43555855	6.288532376	32.43448557	12.84182663	179.3948944	0.56472536	1.758414292	6.268061712	26.59844881	15.03795147	339.3130798	0.950033238	20.61951303	350.7852783
1997	Steelhead	0.759434015	0.712003333	0.539227546	135.4	139.4	144.17	0.021068479	1135.990279	53918.95	12.50019671	36.28554782	13.66737734	402.264859	0.77004555	18.45291065	4.522839576	40.98663387	12.31893101	278.3939758	0.599739084	9.472418499	5.405610532	30.45289397	14.5036122	485.5736287	0.892607699	23.53283707	489.7180481
1998	Steelhead	0.741345155	0.681550957	0.503869771	135.45	140.82	146.72	0.019318579	973.3395526	50383.6	15.34761898	32.00866999	13.93180993	278.206958	0.780110818	13.29050341	6.541228354	32.41294143	12.59972115	182.7302704	0.566950029	1.400267959	6.250604719	26.7339954	14.78032986	340.0581309	0.949951867	20.70722834	346.8958435
1999	Steelhead	0.735202485	0.678598436	0.497529727	135.6	142.02	148.25	0.017462989	868.7751627	49749.51	16.34202373	30.6490089	13.88972187	256.7466543	0.783273435	12.6803776	7.252887338	29.75720051	12.55112495	160.0165802	0.569751945	1.204191852	6.542131051	25.452573	14.71388133	314.4234009	0.952821881	19.6086301	329.3964539
2000	Steelhead	0.733673095	0.606433307	0.443695059	135.57	142.35	147.61	0.018258965	810.0845434	44366.4	16.99181397	29.83048687	14.7253322	208.8579346	0.793649739	11.71796535	7.506283164	29.4555869	12.91635971	147.3700684	0.573427394	0.91015079	6.942225128	23.61794728	15.85537958	247.4620183	0.973956168	18.15734537	257.2190857
2001	Steelhead	0.71710725	0.626545658	0.448059064	135.6	142.5	148.76	0.017425671	780.722854	44803.03	19.1070514	27.70871838	14.14318123	166.1378138	0.802364115	10.25062747	9.107779533	25.42240899	12.75110168	123.8293716	0.602994269	0.936691439	7.459964827	21.63013141	15.03777107	194.8528468	0.966688633	15.71689812	200.1593781
2002	Steelhead	0.723388257	0.663901166	0.478932125	135.62	142.85	149.01	0.017053726	816.7012467	47889.9	17.37674655	30.34926267	13.96239942	247.9024567	0.789766066	12.57497528	8.182331026	29.43426811	12.30848198	165.5746246	0.581743518	1.771069932	6.653793886	24.90293071	15.01640304	296.4957275	0.958887686	18.96787882	311.4447021
2003	Steelhead	0.732488101	0.67556408	0.493476343	135.54	142.04	148.54	0.017662575	871.5472374	49344.29	16.86812851	30.09126228	13.58914769	242.468104	0.78635565	12.2622056	7.570248693	29.22944171	12.36608601	157.1286438	0.57066862	1.04959203	6.746949852	24.54075589	14.39727052	289.6742605	0.959270308	18.7934444	312.3175659
2004	Steelhead	0.726060523	0.647534844	0.46885122	135.55	141.94	148.41	0.017408848	816.1607445	46881.95	17.91925527	28.90860857	13.98726947	199.1722122	0.797959028	11.45155608	8.265043974	27.4400297	12.59479713	133.9851105	0.58391681	0.717633802	7.110605761	22.9956605	14.87111139	236.0294495	0.974578917	17.65118885	256.798645
2005	Steelhead	0.734120228	0.619908961	0.453830668	135.57	141.54	147.5	0.018219938	826.8245945	45380.21	17.18535925	29.45607205	14.89809316	200.2091497	0.797452036	11.53111842	7.712878436	28.352012	13.54653244	136.3704254	0.583379075	0.704584932	6.932889417	23.56056564	15.8304828	244.0730158	0.973113924	18.20176498	246.9970093
2006	Steelhead	0.729636035	0.693616759	0.504690628	135.59	142.25	147.08	0.018889305	953.2617891	50465.69	16.0997559	31.98784879	13.49643078	305.7730459	0.774704952	14.25509721	7.565072745	31.13890094	11.97887688	188.3767883	0.574300763	2.771722221	5.978578418	27.7469316	14.43987783	383.4224904	0.927683165	21.31107648	393.2098389
2007	Steelhead	0.742696224	0.631368505	0.467620333	135.43	140.4	146.38	0.01915631	895.7274113	46758.87	15.95325197	30.87303947	14.77835929	224.5832499	0.790285942	11.8406527	6.590066731	32.11987308	13.3954958	176.5461212	0.567748344	0.983233666	6.818776578	24.015858	15.70522499	258.7680232	0.97314171	18.40714137	261.8122253
2008	Steelhead	0.699838332	0.678834413	0.473761763	136.02	143.61	148.84	0.017183756	814.0502116	47373.24	19.2836508	30.12458637	14.0471817	288.2418869	0.789833438	13.93297168	10.68005586	25.72656759	12.46611671	158.2285477	0.613908279	2.740326691	6.068176225	27.37324489	15.09450038	371.1837616	0.928215156	20.71345536	389.9797363
	Steelhead	0.730768448	0.661022027																										

4 **Table 4-3. Snake River MO1, MO2, MO4, Spring Chinook Raw Data**

Year	Species	InRivSurvSNK	InRivSurvLCol	InRivSurv	ProportionTransported	MedDayLGR	MedDayConfl	MedDayBONinriv	MedDayBONtrans	meanTravelTime	meanMigRate	meanTemp	meanFlow	meanFSpill	meanGas	SNKTravelTime	SNKMigRate	SNKTemp	SNKFlow	SNKFSpill	SNKGas	LCTravelTime	LCMigRate	LCTemp	LCFlow	LCFSpill	LCGas	BonFlow	propBONinriv	propBONtrans	JDAInRivSurv	DeschInRivSurv	BONInRivSurv	JDATime	JDAMigRate	JDATemp	JDAFSpill	JDAGas	DESTime	DESMigRate	DESTemp	DESFSpill	DESGas	BONTTime	BONMigRate	BONTemp	BONFSpill	BONGas	monte_q975	monte_q025					
SCN NAA-RESSIM																																																							
1929	Chino ok_1	0.796 13947 8	0.647 70081 2	0.515 66018 7	0.365 75647 4	126.1 2	135.0 1	142.1 6	133.8 1	20.93 80718 4	24.44 47102 9	12.65 38831 2	141.2 85913 5	0.828 38063 2	12.93 34224 6	10.62 07490 1	11.34 73903 9	11.49 41362 4	60.04 29252 6	0.774 14059 6	10.96 01057 1	7.804 25033 7	22.13 05811 8	13.17 54783	183.8 76981 1	0.787 77121 5	13.41 23582	206.1 53945 9	0.491 59162 3	0.508 40837 7	0.717 53183 4	0.848 85711 6	0.898 18125 6	5.323 83809 2	23.93 82859	13.32 43253 7	0.831 94479 9	14.84 20917 5	1.980 51799 1	20.27 95929 5	13.43 60386 5	0.819 38227	14.91 08867 6	1.543 57681 4	16.46 45361 7	13.49 12686 3	0.814 15683	15.77 16674 8	0.590 26090 2	0.406 61298 2					
1930	Chino ok_1	0.804 27846 7	0.624 33292 1	0.502 13752 4	0.125 28386 5	103.4 7	118.1 8	126	135.1 1	26.06 37043 9	19.99 39969 7	12.13 48038 4	134.5 67730 2	0.822 63188 3	12.54 29602 7	13.99 85044 2	9.138 95674 8	10.01 21425 6	63.47 01561 2	0.751 69612 6	10.22 99287 8	8.940 76900 9	18.54 53909 1	12.86 85835 2	170.9 40198 3	0.793 24777 8	13.10 81396 9	178.6 5	0.790 96169 5	0.209 03830 5	0.697 56643 5	0.831 41161 6	0.881 56478 4	6.135 19292 3	19.93 95292	13.07 25498 2	0.840 00910 5	14.55 62807 1	2.399 43005 9	16.89 65734 1	13.41 94196 1	0.832 89945 1	14.70 51614 1	1.881 07880 2	13.58 16977 4	13.71 13078 9	0.835 23541 1	15.71 50856 8	0.572 2	0.404 11951 4					

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Appendix E: Fish, Aquatic Macroinvertebrates, and Aquatic Habitat

Year	Species	InRivSurvSNK	InRivSurvLCol	InRivSurv	ProportionTransported	MedDayLGR	MedDayConfl	MedDayBONinriv	MedDayBONtrans	meanTravelTime	meanMigRate	meanTemp	meanFlow	meanFSpill	meanGas	SNKTravelTime	SNKMigRate	SNKTemp	SNKFlow	SNKFSpill	SNKGas	LCTravelTime	LCMigRate	LCTemp	LCFlow	LCFSpill	LCGas	BonFlow	propBONinriv	propBONtrans	JDAInRivSurv	DeschInRivSurv	BONInRivSurv	JDATime	JDAMigRate	JDATemp	JDAFSpill	JDAGas	DESTime	DESMigRate	DESTemp	DESFSpill	DESGas	BONTTime	BONMigRate	BONTemp	BONFSpill	BONGas	monte_q975	monte_q025	
1931	Chino ok_1	0.786 08022 2	0.610 75637 6	0.480 10350 3	0.087 39327 3	105.4 8	120.6 1	128.1 7	136.9 9	27.32 40385 6	19.68 38528	12.20 68461 7	122.7 68589	0.838 03744	12.66 25809	15.36 50270 3	7.805 16093 8	9.924 27005 8	43.79 97116 1	0.789 57310 9	10.96 39595	8.880 56466 7	18.62 64539	13.10 54334	159.2 84517 9	0.797 44312 2	12.85 06487 2	172.5 91827 4	0.845 49686 7	0.154 50313	0.685 64545 2	0.825 90393 1	0.877 12886 3	6.123 49746 4	19.99 60749 4	13.30 49852 4	0.845 28865 8	14.44 27049 6	2.381 84542 2	16.99 84888	13.61 08690	0.836 03719	14.49 02556 7	1.865 35424 7	13.69 22072 9	13.85 98275 2	0.839 63421	15.48 22754 9	0.555 34485	0.376 64410 3	
1932	Chino ok_1	0.831 99621 9	0.714 98872	0.594 86791 1	0.324 07728 3	118.0 8	126.0 9	133.3 7	130.1 8	21.52 80799 6	23.51 27615 8	11.78 87538 5	229.5 65555	0.800 68797 3	14.67 67128 5	10.97 35034	11.78 65473 3	10.32 66498 6	0.727 96441 3	11.56 06050 5	7.686 70176 7	18.62 88019	13.10 23967	159.2 18903 6	0.797 63535	15.13 45737 8	320.2 58575 4	0.573 47264 1	0.426 52735 9	0.769 03268 8	0.869 31171 6	0.914 62768 5	5.206 85934 3	12.49 63762 3	0.783 63493	16.99 68318 9	1.923 41771	20.88 13638 7	12.75 57582 9	0.801 20178 1	17.61 36086 8	1.499 45428 2	16.94 00269 7	12.94 35873	0.791 01136 3	18.76 91164	0.660 13535 6	0.491 71670 4			
1933	Chino ok_1	0.788 05154 3	0.605 34933 3	0.477 04647 6	0.298 62104 7	132.6 3	141.1 9	147.7 4	139.9	19.51 74532	26.54 11348 6	13.45 91301 5	189.5 28141 8	0.827 05640 8	13.84 25530 7	10.11 45164 2	11.84 75057 4	11.96 13096 2	60.38 76899	0.794 20423 5	11.27 43282	7.026 90359	25.14 73771	14.10 04366	254.4 69599	0.767 96165	14.17 99845	278.4 81201	0.547 44184	0.452 55815	0.683 13956	0.833 58308	0.885 49665	4.776 93005	27.29 02674 5	14.24 75271	0.803 72133	16.06 58411	1.738 03594	23.03 54694	14.41 80539	0.803 52910	16.51 82183	1.351 56213	18.77 60675	14.54 48436	0.791 26822	17.55 34219	0.569 93249	0.366 02898	
1934	Chino ok_1	0.789 89474 5	0.579 00521 9	0.457 35318	0.128 48651 1	115.1 4	123.1 5	128.8 4	131.2 8	21.32 77173	22.86 47569	13.11 43912	224.5 40247	0.836 05360	14.96 52850	10.75 56742	11.86 82340	11.57 97706	75.77 51144	0.809 11862	12.21 22526	7.559 78472	22.21 04398	13.72 46522	306.1 56082	0.776 52677	15.38 45630	312.4 60479	0.772 97781	0.227 02218	0.663 29551	0.826 77969	0.880 42932	5.350 33400	23.71 30008	13.84 46659	0.780 51841	17.40 72805	2.022 42116	19.92 65594	14.00 40814	0.799 65754	17.73 20140	1.580 82206	16.08 21797	14.14 49108	0.785 69850	18.86 97423	0.534 94793	0.380 889	
1935	Chino ok_1	0.789 34422	0.594 60129 6	0.469 34509	0.367 29687 5	126.7 1	135.1 6	142.2 2	133.8 7	19.55 10262	25.56 45386	13.45 06761	178.7 14940	0.818 49529	13.32 23544	9.788 75538	12.23 41573	12.03 91185	65.21 91885	0.767 19393	10.73 37898	7.253 92773	23.95 38928	14.07 29009	237.7 16746	0.770 49454	13.82 83871	252.4 91957	0.464 91957	0.535 08042	0.674 05881	0.832 34741	0.884 95687	4.997 18096	25.86 67499	14.20 14722	0.806 98001	15.65 81640	1.843 43311	21.76 85147	14.32 80344	0.797 53005	15.99 65419	1.436 30018	17.67 62137	14.43 97716	0.781 39817	16.95 09544	0.567 63814	0.360 13346	
1936	Chino ok_1	0.845 41877 8	0.723 34017	0.611 52536	0.333 06194	115.7 5	122.4 5	129.9 6	129.8 2	20.00 47408	24.02 56732	11.31 31745	249.2 83197	0.768 97197	15.70 12426	9.354 55031	13.78 78886	10.08 54473	124.7 71235	0.623 50896	13.40 18035	7.761 94582	22.40 51816	11.68 54357	311.3 92405	0.774 67773	15.74 38005	324.6 94519	0.567 96749	0.432 03251	0.781 12522	0.879 83570	0.924 24735	5.275 24862	24.27 44242	11.87 70486	0.782 65582	17.50 33256	1.959 75626	20.51 03262	12.09 92692	0.803 11973	18.01 07307	1.528 66638	16.62 12232	12.28 16157	0.791 88400	19.24 77197	0.661 82859	0.529 57934	
1937	Chino ok_1	0.798 98363 6	0.630 16537	0.503 49182	0.348 3651	123.6 1	131.8 9	138.2 4	132	22.54 63083	22.65 03189	12.54 36685	145.0 93074	0.814 10057	12.75 64989	11.74 60737	9.855 06356	10.97 25696	58.86 92665	0.742 55452	10.47 76328	8.086 60432	21.05 94641	13.21 62075	188.1 33270	0.780 77305	13.21 91220	201.5 52993	0.502 85723	0.497 14276	0.700 04357	0.835 77268	0.886 29769	5.524 90826	22.73 60289	13.39 0798	0.826 68932	14.75 93158	2.096 06980	19.22 75600	13.57 50939	0.817 06750	14.96 65419	1.637 81511	15.53 55298	13.69 78611	0.811 87701	15.99 93691	0.599 52503	0.396 15252	
1938	Chino ok_1	0.818 68592	0.613 32258	0.502 11857	0.517 95581	128.9 7	134.7	138.7 2	140.0 5	18.04 00598	26.63 88801	13.13 85077	233.8 86496	0.788 28579	15.21 41527	8.452 58310	14.92 51212	11.72 97826	108.1 47283	0.682 93556	12.74 19267	7.048 87062	24.52 98230	13.65 33908	301.6 24415	0.770 22068	15.47 82469	311.0 75408	0.334 26143	0.665 73856	0.688 95001	0.837 65544	0.888 93780	4.888 15695	26.42 99567	13.80 45763	0.780 50187	17.28 70647	1.808 74463	22.20 81530	14.00 07219	0.800 01121	17.62 76404	1.410 69608	17.99 38720	15.53 82956	14.17 07716	0.788 04352	18.83 38565	0.576 4205	0.412 33592
1939	Chino ok_1	0.825 47866	0.701 95400	0.579 44806	0.322 22313	115.0 6	123.3 1	130.9 3	128.1 5	21.24 22290	23.17 47036	11.50 06078	196.3 00661	0.791 31450	13.69 44618	10.30 92631	12.27 96745	10.58 09560	89.40 58883	0.699 77660	11.15 28671	8.058 02065	21.57 33872	11.82 02792	252.7 40893	0.763 25369	14.27 38153	261.1 76738	0.567 96738	0.432 23262	0.765 65832	0.874 43076	0.920 40987	5.424 30907	23.42 20619	11.94 73453	0.796 34974	15.90 06059	2.042 53593	19.72 75968	12.06 99482	0.787 19987	16.33 32522	1.596 17224	15.93 11218	12.14 79554	0.765 91944	17.29 46157	0.629 76281	0.495 51702	
1940	Chino ok_1	0.817 38942	0.716 11301	0.585 34320	0.071 43475	94.97	111.4 3	120.2 4	136.7 1	28.92 55232	18.41 46830	10.96 33511	173.7 40910	0.769 61204	12.75 52630	15.96 47479	8.904 49771	9.242 45414	81.64 22256	0.639 99629	9.576 04866	9.311 54228	17.98 84762	11.45 03599	219.7 34853	0.762 43142	13.66 03473	229.9 12918	0.891 24343	0.108 75656	0.772 94222	0.869 33838	0.914 24953	6.257 03287	19.45 98922	11.66 26827	0.805 16614	15.18 73319	2.453 41683	16.53 64370	12.00 38696	0.800 01360	15.48 50171	1.924 01862	13.28 69550	12.28 77564	0.785 77551	16.54 80341	0.639 20514	0.484 07356	
1941	Chino ok_1	0.741 15667	0.472 96688	0.350 54256	0.360 4899	130.1 2	134.4	136.7 2	145.4 2	20.14 47473	24.76 99864	14.46 91758	141.8 91758	0.827 54391	12.80 19820	9.954 86451	11.97 69789	13.24 36359	58.03 63281	0.768 33064	10.70 61313	7.750 11450	21.59 79892	14.91 86636	185.2 69060	0.790 66065	13.17 09578	193.0 79849	0.404 67288	0.595 32712	0.577 98415	0.779 92291	0.840 11411	5.450 74850	23.09 30084	14.99 94983	0.833 9095	14.77 28956	2.077 44017	19.41 54764	15.16 50095	0.823 31347	1.624 51782	15.00 07524	15.32 91311	0.820 09634	15.95 40081	0.439 97941	0.260 53227		
1942	Chino ok_1	0.809 05504	0.665 60294	0.538 50942	0.528 7513	134.3 5	137.7 8	143.4 6	145.6 2	20.01 76236	25.63 65455	12.87 12887	192.6 62659	0.787 49955	13.64 19319	10.10 83837	12.02 73965	11.32 10340	85.48 24035	0.677 84559	10.60 72631	7.511 56845	23.13 07433	12.99 47834	245.8 83023	0.772 62781	14.28 80966	254.6 29806	0.339 04693	0.660 95306	0.731 98707	0.857 2483	0.905 50869	5.076 30029	25.08 99413	13.16 16340	0.802 57766	15.98 35474	1.904 84437	21.12 43777	13.34 77846	0.806 30938	16.36 59359	1.487 54438	17.07 48959	13.50 90026	0.796 57858	17.45 30859	0.605 85357	0.461 17559	
1943	Chino ok_1	0.833 70118	0.679 46485	0.566 47065	0.391 06366	121.4 8	124.8	130	130.4 9	21.63 65786	23.13 67120	11.87 73460	226.6 44014	0.772 93727	15.21 06901	10.79 946	12.84 05173	10.45 82723	117.3 23515	0.637 56326	13.36 00688	7.888 26095	21.57 68941	12.35 77960	286.7 59094	0.772 21838	15.27 20869	300.0 59783	0.484 04395	0.515 95604	0.739 88060	0.857 27722	0.904 79372	5.435 85669	23.24 93770	12.54 93770	0.787 32748	16.93 19126	2.050 65187	19.64 57342	12.77 80402	0.806 35176	17.19 19107	1.602 19004	15.87 28467	12.96 28467	0.797 28467	18.33 5	0.648 6	0.474 11817	
1944	Chino ok_1	0.789 37584	0.573 69023	0.452 85721	0.466 90684	130.7 7	138.7 7	145.5 8	137.9 9	20.12 30993	24.98 51270	13.43 69314	138.0 51470	0.818 61661	12.72 03347	10.00 56488	11.76 84758	11.98 40040	66.19 07478	0.737 44870	10.62 55411	7.697 63215	22.06 44557	14.07 09192	174.5 33505	0.795 56516	13.16 02067	177.7 63732	0.357 07863	0.642 92136	0.652 85217	0.814 02553	0.867 85688	5.334 62198	23.72 88441	14.22 20514	0.842 01322	14.62 78200	2.025 07033	19.90 99573	14.38 42353	0.833 9534	14.72 27198	1.583 44405	16						

Columbia River System Operations Environmental Impact Statement
Appendix E: Fish, Aquatic Macroinvertebrates, and Aquatic Habitat

Year	Species	InRivSurvSNK	InRivSurvLCol	InRivSurv	ProportionTransported	MedDayLGR	MedDayConfl	MedDayBONinriv	MedDayBONtrans	meanTravelTime	meanMigRate	meanTemp	meanFlow	meanFSpill	meanGas	SNKTravelTime	SNKMigRate	SNKTemp	SNKFlow	SNKFSpill	SNKGas	LCTravelTime	LCMigRate	LCTemp	LCFlow	LCFSpill	LCGas	BonFlow	propBONinriv	propBONtrans	JDAInRivSurv	DeschInRivSurv	BONInRivSurv	JDATime	JDAMigRate	JDATemp	JDAFSpill	JDAGas	DESTime	DESMigRate	DESTemp	DEFSpill	DESGas	BONTTime	BONMigRate	BONTemp	BONFSpill	BONGas	monte_q975	monte_q025
1949	Chino ok_1	0.806 19650 1	0.555 44169 1	0.447 79514 8	0.593 72000 5	126.4 7	131.9 8	137.2 9	133.1 7	16.63 56979 9	27.83 00489 9	13.77 65119 4	271.8 22123 4	0.782 30298 3	16.55 23198 6	7.425 13893 5	16.98 66952 8	12.37 05276 5	124.5 61753 8	0.660 95881 5	13.71 31053 9	6.578 64384 4	26.47 05420 4	14.44 64705 8	347.8 95914 7	0.774 57465 7	16.82 37041 6	379.7 36114 5	0.248 99835 5	0.751 00164 5	0.651 26244 5	0.825 45792 6	0.879 29735 1	4.601 01442 5	28.48 05468 1	14.52 84124 4	0.777 67484 2	18.64 29103 9	1.642 06989 1	24.35 61461 5	14.62 07971 6	0.827 43010 9	19.03 47118 4	1.275 71310 1	19.89 07444 4	14.71 08779 3	0.825 67715 6	20.31 59751 9	0.527 14793 3	0.341 63089 6
1950	Chino ok_1	0.819 56645 4	0.668 74473 3	0.509 08075 5	0.509 26005 5	131.9 4	137.2 6	143.1 2	139.4 4	18.65 27392 3	26.73 04352 6	12.67 20335 8	217.3 73101 4	0.798 11953 6	14.45 27714 6	13.58 23958 1	11.48 08372 7	11.48 23713 3	93.84 89990 2	0.707 62399 4	11.78 39275 4	7.057 49683 7	24.93 50318 4	13.15 62932 3	281.0 59269 4	0.772 95251 3	14.84 42120 4	0.361 45906 6	0.638 54093 4	0.733 18361 7	0.856 72133 6	0.904 96675 1	4.799 38107 3	27.04 12235 3	13.32 22129 8	0.793 55254 2	16.63 86714 9	1.760 37400 2	22.77 73089 9	13.48 07596 2	0.803 63933 2	17.09 38555 4	1.370 81971 3	18.51 35881 3	13.58 04548 3	0.792 16489 2	18.20 88213 3	0.629 81947 2	0.443 17596 5	
1951	Chino ok_1	0.824 36319 6	0.625 69752 7	0.515 80201 3	0.522 12336 3	130.3 2	133.7 5	139.1 2	138.0 9	18.10 22359 6	26.92 22436 4	13.20 22335 2	260.3 89486 6	0.798 96907 3	16.05 89391 2	8.778 45852 1	14.44 83982 1	11.61 23464 6	106.4 52043 2	0.712 86273 3	12.91 35644 9	6.803 12997 1	25.40 19558 1	13.84 08101 4	338.7 95979 8	0.770 20899 5	0.336 30517 6	0.663 28221 3	0.695 28221 3	0.839 34796 4	0.890 22003 4	4.733 91968 8	27.34 35939 8	14.00 96553 8	0.769 63465 2	18.31 81264 9	1.736 90167 1	23.10 81592 5	22.77 76307 9	13.48 20765 9	0.803 93850 6	18.72 84258 6	1.353 84258 6	18.74 44594 8	14.37 04137 8	0.807 88436 5	20.12 18519 2	0.589 17657 1	0.427 87176 1	
1952	Chino ok_1	0.849 68530 6	0.732 15883 4	0.622 10460 3	0.604 30885 1	123.2 7	122.6 9	130.0 1	133.2 2	18.29 31995 2	25.92 60506 9	11.56 58160 6	291.5 23741 3	0.755 92367 6	17.82 63801 2	8.186 19564 2	16.54 75383 5	10.45 29852 3	161.9 29852 3	0.588 12216 5	16.22 36282 3	7.340 71828 4	23.56 77153 7	11.84 42935 2	358.7 27209 5	0.773 42593 8	17.40 44976 4	0.302 42593 8	0.697 57406 2	0.783 06470 2	0.878 88622 9	0.923 04639 1	5.042 80115 7	25.45 48988 2	12.04 83535 8	0.763 91726 7	19.00 33607 5	1.861 96856 2	21.58 26167 9	12.27 70945 2	0.819 70129 4	19.26 50814 1	1.452 58589 1	17.47 96699 3	12.46 69404 3	0.819 79659 2	20.68 37797 2	0.679 21860 3	0.533 44038 3	
1953	Chino ok_1	0.818 66753	0.655 18318 4	0.536 37719 9	0.415 83417 3	130.7 8	133.0 1	140.0 7	143.6 2	20.22 76518 2	25.25 88500 3	12.69 30343 8	209.9 23741 5	0.799 79320 1	14.35 79324	10.34 07482 2	11.73 89778	11.10 58446 9	85.41 44424 9	0.714 59538 9	11.55 71199	7.400 13225	23.43 27310	13.32 85369	269.4 68821	0.770 94955	14.73 60534	283.8 67703	0.447 32296	0.552 88812	0.722 88812	0.851 03909	0.899 81344	5.028 72593	25.38 05057	13.49 1329	0.798 80298	16.52 50474	1.869 09560	21.49 99644	13.70 20870	0.803 73567	16.98 74394	1.458 06883	17.41 74662	13.87 74662	0.792 56710	18.11 02724 4	0.589 47746	0.467 17099
1954	Chino ok_1	0.820 23221 1	0.661 45037 1	0.542 5429	0.416 63992	140.5 3	148.5 5	149.8 3	143.7 1	18.59 07852 1	27.28 10586 4	12.74 72104 3	233.6 88429 2	0.820 55946 8	15.57 03294 6	9.420 80146 8	12.96 56123 6	11.39 06040 5	90.05 16128 5	0.760 76221 5	12.55 01827 2	6.799 05718 6	25.88 05588	13.31 38474 5	302.7 67039	0.780 59196	15.93 59196	310.4 66125 5	0.448 38089 8	0.551 61910	0.727 58365	0.855 29533	0.903 92064	28.08 08058	13.46 76826	0.789 41412	17.64 73802	1.699 79140	23.60 10061	13.61 76122	0.809 00087	18.01 31254	1.324 35798	19.16 04136	13.72 42612	0.801 20372	19.37 53204	0.620 92118	0.460 38849	
1955	Chino ok_1	0.810 56769 9	0.649 86265 7	0.526 75767 9	0.583 10561 2	134.8 3	139.6 4	145.3 1	142.7 4	19.03 70893	26.29 34080	12.89 12589	192.6 18479	0.791 19736	13.67 33484	9.367 48552	12.94 98093	11.51 66925	86.78 80706	0.686 58464	10.93 33549	7.260 02309	24.02 23665	13.41 37374	245.0 40969	0.773 97370	256.9 95971	0.286 53882	0.718 46117	0.849 66188	0.898 63239	4.938 63961	26.02 90513	13.57 62418	0.806 03385	15.89 02196	1.830 90560	21.93 36146	13.78 08637	0.802 90907	16.24 90758	1.427 22243	17.78 76684	13.95 58873	0.789 63568	17.30 18107	0.604 68996	0.424 14316		
1956	Chino ok_1	0.853 96741 5	0.732 89281 8	0.625 86658 6	0.324 18177 4	116.0 2	120.6 6	128.0 7	134.7 3	19.55 30979	24.72 32417 6	11.36 94887	297.4 12771	0.798 65450	18.40 68150	9.222 11528	14.99 08969	10.13 30469	144.5 93344	0.681 12168	15.76 11206	7.457 87292	22.91 65646	11.68 89933	383.7 40768	0.795 92622	19.03 08960	0.581 56787	0.418 85031	0.785 58964	0.880 72221	0.924 49277	5.134 65338	24.70 43002	11.89 66440	0.784 53352	20.82 32353	1.908 27154	21.08 70131	12.14 46778	0.828 09195	20.52 82319	1.490 28959	17.04 26889	12.36 22331	0.820 82182	21.66 63608	0.671 96789	0.555 99297	
1957	Chino ok_1	0.828 86637 4	0.716 48260	0.593 86834	0.378 83067	114.5 2	121.2 9	128.6 7	138.2 8	21.55 51035	23.56 77123	11.61 58348	272.6 32748	0.789 7972	16.62 77791	11.01 63817	11.70 19175	10.35 14219	113.4 61831	0.685 70966	12.92 90832	7.742 90605	22.35 14158	11.94 83176	339.4 43573	0.771 66844	16.87 72296	358.0 35123	0.512 64876	0.487 89159	0.779 89159	0.878 23521	0.922 38395	5.206 09351	24.26 15019	12.10 67697	0.786 56321	18.85 40447	1.931 45205	20.79 94132	12.36 27980	0.822 19952	19.51 98758	1.505 99005	16.86 77579	12.60 60538	0.817 24751	20.99 02687	0.638 47334	0.526 77297
1958	Chino ok_1	0.824 87932 9	0.647 20626 4	0.533 86706 9	0.556 45249 9	124.9 3	130.8	136.8 6	136.8 3	17.12 83104	28.11 85294	12.80 51403	275.9 17166	0.793 70389	16.84 91975	8.059 59543	15.57 05885	11.52 96987	12.13 10063	0.696 40680	13.90 71104	6.569 45239	27.04 63457	13.37 41579	353.6 55700	0.771 63738	17.09 90542	373.9 01092	0.314 50321	0.685 49678	0.723 02643	0.855 43047	0.904 20792	4.498 27371	29.31 98449	13.50 55851	0.778 14710	18.98 51390	1.609 72304	24.87 26234	13.62 39996	0.821 69624	19.47 64029	1.251 85279	20.27 07767	13.68 98737	0.819 30160	20.66 12491	0.595 74589	0.452 19994
1959	Chino ok_1	0.802 96142 9	0.573 86649 5	0.460 79266 1	0.456 93459 5	135.2	140.6 2	144.7 7	143.5 1	18.24 68154	27.49 16883	13.69 29033	227.8 54444	0.813 72390	14.69 18907	9.156 9556	13.37 71561	12.07 04450	82.75 50231	0.754 60676	11.56 32864	6.730 91879	25.89 74964	14.43 37900	304.9 67427	0.769 85021	15.25 66171	318.0 57861	0.629 61868	0.655 38131	0.823 72515	0.878 80775	4.646 31262	27.96 99405	14.56 99405	0.783 15678	17.31 78314	1.704 78314	23.53 30358	14.70 85453	17.76 55807	17.76 50521	1.328 30134	14.81 36845	0.789 91466	18.87 71333	0.546 32377	0.357 19788		
1960	Chino ok_1	0.808 66746 4	0.634 97849	0.513 48645	0.480 55075	134.0 2	140.4 9	144.6	140.0 4	19.27 82105	26.32 13034	12.97 83870	205.9 89191	0.799 79328	14.05 40822	9.724 78249	12.55 14227	11.51 40399	81.45 13732	0.720 10693	11.28 56445	7.126 16027	24.61 39528	13.54 61950	269.0 37167	0.766 09545	14.46 36333	284.2 11608	0.371 77454	0.628 22545	0.708 02241	0.847 63301	0.897 55150	4.848 05215	26.68 65293	13.69 9	0.794 10986	16.35 89435	1.785 17805	22.47 26301	13.87 08855	0.798 83859	16.79 36258	1.390 74792	18.25 00603	14.02 61602	0.785 39514	17.87 49656	0.591 98353	0.419 02573
1961	Chino ok_1	0.800 42247 5	0.622 83332	0.498 52979	0.195 72402	118.8 5	127.9 3	134.9 4	136.2 1	21.90 97334	23.45 24830	12.79 827	199.6 54285	0.818 25844	13.96 83205	11.56 10225	10.28 20698	10.98 00718	61.53 87840	0.778 91107	11.06 95486	7.635 33317	22.56 96679	13.59 59650	267.3 03749	0.760 17714	14.31 76215	275.8 21258	0.690 14432	0.309 85567	0.696 50116	0.839 56602	0.890 47515	5.226 38069	24.38 75167	13.75 17980	0.792 60423	16.36 46251	1.949 75167	20.64 41153	13.92 25177	0.799 15553	16.85 88914	1.522 98113	16.68 72721	14.05 71003	0.785 82668	17.99 53393	0.571 46342	0.413 42069
1962	Chino ok_1	0.827 13678 5	0.672 70364 3	0.556 41792	0.328 62777	119.3 5	127.2 1	134.1 3	130.1 4	20.57 53360	23.87 85749	12.27 98123	198.2 74013	0.792 75834	13.81 75395	10.02 64440	12.27 19225	10.79 15689	87.19 17495	0.706 93653	11.40 47290	7.776 64101	22.40 51098	12.82 69098	258.																									

Columbia River System Operations Environmental Impact Statement
Appendix E: Fish, Aquatic Macroinvertebrates, and Aquatic Habitat

Year	Species	InRivSurvSNK	InRivSurvLCol	InRivSurv	ProportionTransported	MedDayLGR	MedDayConfl	MedDayBONinriv	MedDayBONtrans	meanTravelTime	meanMigRate	meanTemp	meanFlow	meanFSpill	meanGas	SNKTravelTime	SNKMigRate	SNKTemp	SNKFlow	SNKFSpill	SNKGas	LCTravelTime	LCMigRate	LCTemp	LCFlow	LCFSpill	LCGas	BonFlow	propBONinriv	propBONtrans	JDAInRivSurv	DeschInRivSurv	BONInRivSurv	JDATime	JDAMigRate	JDATemp	JDAFSpill	JDAGas	DESTime	DESMigRate	DESTemp	DESFSpill	DESGas	BONTTime	BONMigRate	BONTemp	BONFSpill	BONGas	monte_q975	monte_q025
1967	Chino ok_1	0.811 4088	0.711 07125 1	0.576 96947	0.337 97743 6	125.1 8	133.4 9	140.4 7	136.6 6	20.88 59963 3	25.16 81227 7	11.99 85624 7	204.4 58863 9	0.825 88369 1	14.25 67133 9	11.09 35694 1	10.68 21057 2	10.82 50917 4	65.69 18289 2	0.788 89173 3	11.29 34209 8	7.298 30435 7	24.18 10001 4	12.42 97113 4	272.7 60093 7	0.769 65251 6	14.67 10653 3	290.2 61596 7	0.549 90051 6	0.450 09948 6	0.768 79407 8	0.873 77143 7	0.919 02321 8	4.913 21686 4	26.29 41386 4	12.59 18268 2	0.798 09311 6	16.63 91145 7	1.798 34831 5	22.31 20950 3	12.75 14715 2	0.813 43899 2	17.11 67780 6	1.401 20709 7	18.11 47878 9	12.87 39209 2	0.807 03204 9	18.25 06880 8	0.635 62014 8	0.480 87966 5
1968	Chino ok_1	0.726 19998 5	0.429 32873 1	0.311 77851 8	0.421 62201 3	139.9 6	143.9 4	145.4 1	147.8 2	17.75 97298 7	27.52 72748 9	15.17 31198 9	180.5 18251 7	0.827 33295 2	13.74 07787 5	8.544 85514 8	14.08 58353 3	14.21 97706 2	70.60 10467 5	0.769 63303 1	11.28 46654 9	6.945 83342 2	24.33 23395 4	15.52 91744 9	234.8 48121 6	0.789 08302 4	14.12 25237 1	245.5 63720 7	0.321 29006 6	0.678 70993 4	0.548 98258 8	0.777 50426 8	0.839 26837 2	4.906 44381 2	26.01 41584 4	15.55 15337 2	0.814 78129 6	15.92 60894 8	1.837 83311 4	21.84 48188 8	15.66 54596 3	0.816 74818 2	16.11 16730 4	1.432 54423 9	17.72 25271 9	15.82 02295 3	0.811 89629 4	17.13 93628 1	0.414 41784 8	0.211 86731 8
1969	Chino ok_1	0.839 67238 8	0.649 03560 6	0.544 97727 7	0.351 57355 9	116.3 2	122.7 8	130.0 6	132.8 2	20.69 37612 5	23.70 92421 8	12.48 69662 9	252.3 20631 3	0.782 49520 9	15.72 86147 7	10.13 19267 8	12.85 33006 9	10.44 84666 8	110.5 26937 9	0.673 76488 1	12.89 95374 3	7.681 82460 9	13.28 11913 5	320.2 05027 3	0.764 76433 9	15.88 10603 6	330.0 44952 4	0.519 26418 1	0.480 73581 9	0.712 76542 7	0.842 84949 8	0.892 45705 4	5.280 68263 8	24.14 91861 3	13.51 49261 5	0.776 94828 5	17.76 62538 5	1.959 50050 7	20.53 26745 1	13.80 02481 3	0.806 31075 3	18.41 96717 4	1.529 79566 2	16.60 91554 6	14.01 03259 1	0.795 79460 6	19.76 19533 5	0.614 42021 8	0.448 82977 7	
1970	Chino ok_1	0.814 99928 9	0.693 15955 2	0.564 92454 2	0.472 14458 6	123.1 8	128.2 5	135.6 3	142.6 2	21.26 87226 5	24.35 66672 9	12.12 1787	188.9 47962 6	0.806 73368 1	14.30 66741 6	10.95 69723 4	10.83 84818 8	10.78 63769 5	84.18 06716 9	0.720 31961 7	12.06 46032 3	7.828 89916 9	22.04 23124 9	12.56 93203 6	231.9 55675 8	0.782 11258 4	14.40 53307 1	238.9 81185 9	0.404 65943 8	0.595 34056 2	0.756 28675 5	0.866 00487 5	0.912 28542 9	5.303 79892 2	23.87 87028 3	12.74 43536 8	0.815 49288 6	15.98 78284 8	1.989 07156 5	20.24 06247 5	12.96 56136 8	0.819 07512 3	16.33 89301 3	1.553 53979 8	16.36 09249 6	13.14 63756 6	0.814 97868 7	17.54 42533 5	0.618 41490 8	0.488 50468 7
1971	Chino ok_1	0.832 37700 9	0.601 89190 4	0.501 00098 3	0.664 16861 6	139.0 1	145.3 7	147.3 9	143.0 4	14.34 73654 7	32.14 18179 8	13.64 85535 8	328.5 60563 2	0.799 33201 8	19.67 56330 9	6.328 47306 3	20.03 18892 3	12.45 13393 4	154.5 69119 3	0.684 30290 2	16.77 25559 2	5.675 75704 3	31.02 52024 3	14.25 84527 3	423.3 25978 6	0.794 85610 1	20.07 06152 3	427.3 06152 3	0.212 89994 1	0.787 10005 9	0.679 3581	0.837 11551 3	0.888 76558	3.938 92323 2	33.49 08292 7	14.36 73078 5	0.775 88285 2	22.06 62071 2	1.393 24983 2	28.77 93819 3	14.42 70296 1	0.846 14900 7	22.01 96717 6	1.084 14789 3	23.44 27327 3	14.45 28532	0.845 67606 8	23.15 73600 8	0.579 23679 8	0.411 50555
1972	Chino ok_1	0.838 0725	0.615 98138 4	0.516 23705 9	0.485 15147 7	122.4 5	126.9 6	133.4 8	137.9 3	17.89 53827 6	26.81 22058 8	13.21 11745 6	286.4 57405 6	0.803 51179 8	17.55 34360 7	8.511 79665 3	14.78 80856 3	11.29 58442 7	122.2 02708 4	0.707 26305 2	14.17 07008 4	6.806 13011 1	25.41 73180 7	14.04 12801 1	366.9 04530 8	0.785 47536 3	18.18 42207 9	369.4 25964 4	0.369 77837 9	0.630 22162 1	0.687 96191 9	0.834 62999 3	0.885 84217 4	4.697 02523 9	27.42 13994 8	14.21 94116 6	0.790 49422 7	20.27 12417 6	1.714 97970 8	23.41 45181 3	14.42 63025 9	0.823 64026 7	20.56 93798 1	1.337 36604 5	18.97 44536 5	14.57 58962 6	0.814 81960 4	21.49 35121 5	0.590 96685 9	0.433 56808 4
1973	Chino ok_1	0.771 38375 6	0.577 02267 9	0.445 10592 2	0.279 41446 6	118.0 7	126.8 8	133.6 3	143.4 8	23.55 34382 5	22.41 00818 6	12.97 22565 2	128.1 10465 7	0.832 91533 2	12.62 39888	12.64 35211 8	9.226 17245 6	11.18 89699 9	50.83 54515 1	0.773 32973 5	10.74 38856 1	8.309 38477 1	20.00 28770 3	13.70 17016 4	162.8 04161 1	12.89 08614 3	170.2 63691 4	0.553 62003 7	0.446 37996 3	0.661 68166	0.817 21821 7	0.834 45830 9	5.779 42843	21.43 63172 2	13.84 80886 5	0.844 38260 8	14.47 53610 6	2.225 95847 4	18.15 67221 7	14.07 12436 4	0.834 73837 7	14.55 85352 6	1.742 28043 1	14.62 86602 7	0.837 31308 6	15.48 33803 2	0.508 70692 9	0.375 81914 2		
1974	Chino ok_1	0.830 94257 1	0.579 76473 1	0.481 51119 6	0.536 38172 4	136.6 5	143.5 4	147.0 9	141.8 7	15.26 44124 6	30.47 38386 6	13.98 59984 3	316.2 70941 6	0.812 77309 6	19.13 09785 7	6.947 17487 7	18.17 93459 9	12.40 00221 3	139.1 32708 7	0.728 76707 3	16.05 15720 4	5.894 48168 9	29.56 34338 4	14.70 50776 5	412.4 96755 2	0.789 16466 2	19.65 76848	417.1 88507 1	0.308 93933	0.691 06066	0.658 61912	0.824 70999 4	0.877 96736 4	4.122 96405 5	31.80 51118 5	14.84 54446 9	0.770 19799 8	21.54 19799 2	1.471 67675 2	27.23 20148 8	14.99 02922 3	0.841 10089 3	21.46 27183 3	1.145 12242 4	22.17 59378 5	15.09 51938 6	0.840 51808 7	22.69 65341 6	0.565 64628 8	0.377 25210 3
1975	Chino ok_1	0.813 86861 9	0.606 23569 6	0.493 39620 3	0.603 08402 1	144.9 3	148.1 7	151.0 3	155.4 3	15.92 02652 5	30.37 89175 5	13.71 94446 8	261.9 52672 7	0.794 78777 7	16.68 02223 5	7.402 50135 2	16.39 78113	12.43 32748 4	123.0 25595	0.686 07120 5	14.03 38405	6.340 74609	27.87 06903	14.14 68744 3	330.9 56705	0.782 77915	16.84 76	341.1 12701	0.258 71046	0.741 28953	0.684 40550	0.837 00930	0.888 15929	4.331 84306	30.21 18500	14.29 87630	0.788 54830	18.76 14547	1.565 46221	25.58 88448	14.51 34636	0.821 90779	19.06 69619	1.217 94472	20.83 75316	14.72 51725	0.816 67894	20.35 41507	0.560 38145	0.417 64475
1976	Chino ok_1	0.845 75755 1	0.737 71287 4	0.623 92623 4	0.527 23139 6	119.6 4	125.0 7	132.3 1	130.7 8	19.60 46702 4	24.85 72784 1	11.45 56908 6	264.0 27861 5	0.774 96258 7	15.99 41271 4	9.370 32882 9	13.87 86397 2	10.22 89873 1	121.7 61062 6	0.644 91319	12.94 92662 7	7.427 99159	23.62 37655	11.88 04205	334.3 31451	0.770 81879	16.39 87021	348.7 32269	0.374 42085	0.625 57914	0.787 91832	0.880 82973	0.924 74259	5.021 70988	25.64 94414	12.08 29738	0.778 79627	18.20 78384	1.836 10379	21.86 80210	12.28 06596	0.813 18799	18.73 71444	1.431 40167	17.73 55182	12.40 84997	0.804 40631	19.96 02823	0.682 38827	0.549 29217
1977	Chino ok_1	0.728 09787 8	0.504 52428 6	0.367 34306 2	0.230 51912	130.8 7	139.1 5	144.3 3	139.3 7	21.57 22170 8	23.72 60355 3	14.04 79337 8	112.3 71706 6	0.847 35849 9	12.54 33813 2	11.15 65633 7	10.28 80137 3	12.85 34785 5	0.803 72217	11.21 3377	7.943 37896	20.91 41703	14.56 49496	150.9 12376	0.807 40174	12.49 98401	156.5 99914	0.578 00680	0.421 99319	0.598 91942	0.787 73548	0.846 00221	5.589 80921	22.33 74770	14.65 00019	0.856 08065	14.14 24428	2.147 82289	18.79 75964	22.33 59282	17.99 85570	14.19 49380	1.680 35335	15.15 28711	14.86 90419	0.859 97146	15.09 45739	0.463 55199	0.281 13885	
1978	Chino ok_1	0.838 34802 6	0.735 84695	0.616 89583 8	0.215 48139 5	109.6 2	120.4 2	128.2 9	128.2 9	24.01 84218 1	21.66 14684 5	11.04 99540 1	201.6 04435	0.785 12998 6	13.67 16638 6	12.60 05363	10.93 43771	9.581 76078	91.79 46884	0.677 81281	10.72 31624	8.367 20483	20.43 97848	11.55 54766	259.6 79738	0.767 12632	14.36 39193	267.2 95929	0.708 63066	0.291 36933	0.787 91115	0.880 33996	0.924 51638	5.656 67812	22.13 16244	11.74 38945	0.793 04475	16.06 53671	2.157 26642	18.70 71503	11.97 05267	0.790 98683	16.44 94415	1.687 13180	15.09 71662	12.15 29960	0.772 28444	17.49 84316	0.670 08974	0.529 90265
1979	Chino ok_1	0.830 32672 8	0.729 25225	0.605 51764 1	0.184 77257 3	113.3	123.3 4	131.0 9	127.8 3	23.85 23908	21.87 69174 9	11.17 45537 3	185.4 22695 4	0.804 02692 3	13.35 77932 6	12.57 86182 1	10.16 89832 7	9.619 64702	72.41 01890	0.735 47183	10.47 62575	8.329 21026	20.82 72532	11.74 99192	243.1 53783	0.763 16999	14.04 57943	253.4 39590	0.745 48572	0.254 51427	0.783 72680	0.877 45323	0.922 0489	5.577 01562	22.63 28634	11.95 05991	0.798 99530	15.70 24108	2.10											

Columbia River System Operations Environmental Impact Statement
Appendix E: Fish, Aquatic Macroinvertebrates, and Aquatic Habitat

Year	Species	InRivSurvSNK	InRivSurvLCol	InRivSurv	ProportionTransported	MedDayLGR	MedDayConfl	MedDayBONinriv	MedDayBONtrans	meanTravelTime	meanMigRate	meanTemp	meanFlow	meanFSpill	meanGas	SNKTravelTime	SNKMigRate	SNKTemp	SNKFlow	SNKFSpill	SNKGas	LCTravelTime	LCMigRate	LCTemp	LCFlow	LCFSpill	LCGas	BonFlow	propBONinriv	propBONtrans	JDAInRivSurv	DeschInRivSurv	BONInRivSurv	JDATime	JDAMigRate	JDATemp	JDAFSpill	JDAGas	DESTime	DESMigRate	DESTemp	DEFSpill	DESGas	BONTTime	BONMigRate	BONTemp	BONFSpill	BONGas	monte_q975	monte_q025
1985	Chino ok_1	0.838 30446 9	0.732 45682 9	0.614 02183 4	0.164 41213	110.5 1	120.8 8	129.2 3	128.8 4	23.84 43301 8	21.40 64891	11.02 96123 4	180.5 80889 6	0.775 28059 1	13.59 25148 2	12.11 77708 1	10.67 65197 6	9.565 65647 1	96.22 57003 8	0.645 62964 4	11.52 01446 5	8.715 42098 4	19.78 50441	11.50 49344 7	224.8 01480 6	0.770 96363 9	13.93 17224	230.2 08969 1	0.771 14559	0.228 85440	0.785 35834	0.877 45684	0.921 72570 8	5.798 03182	21.51 58363 8	11.73 25489	0.809 73385 6	15.45 79887	2.219 21762 1	18.21 04162 5	11.98 31492 3	0.802 66380 3	15.76 35943 1	1.737 06107 6	14.66 94204 3	12.16 86272 6	0.789 68277 6	16.82 29904 2	0.672 71811	0.517 11529 3
1986	Chino ok_1	0.799 34314 2	0.600 15228 1	0.479 72761	0.379 70931 1	118.6	122.5 9	128.7 3	141.4 3	21.64 54561	23.28 07787	12.86 94443 7	200.2 87332 3	0.774 29253 3	14.06 75808 7	10.77 39002 9	12.39 56346 2	11.18 14392 1	102.8 26561	0.649 34926	11.61 81783 7	8.110 56034 3	20.82 19558 1	13.38 30946 3	250.7 25074 8	0.765 55837 2	14.47 28791 7	251.4 71435 5	0.458 03120 4	0.541 96879 6	0.691 76727 8	0.835 08411 2	0.885 97008 2	5.567 27473 4	22.43 26660 2	13.52 23011	0.797 26052 3	16.02 43522 6	2.135 20623 7	18.93 28191 6	13.84 26650 4	0.800 06452 4	16.43 21934 4	1.672 52369 2	15.22 07545 1	14.15 15264 5	0.785 96746 9	17.56 06722 8	0.543 72866 3	0.410 20320 3
1987	Chino ok_1	0.752 78047 3	0.514 09448 8	0.387 00029 1	0.183 74532 5	118.5 5	126.9 2	132.3 4	128.6 7	19.96 84301 9	24.29 92185	13.91 51867 5	206.0 02417	0.832 38927	14.24 33233 3	9.888 53831 6	12.39 18142	12.63 28350 1	63.06 39717 1	0.805 11983 6	11.38 98941	7.297 25320 6	23.37 81923	14.47 43512 5	283.4 68271 9	0.771 30878	14.74 60651	292.5 38421	0.658 03609	0.341 96390	0.614 99228	0.806 76745	0.863 96184 8	5.149 29635	25.03 01480 5	14.54 35131	0.789 57115	16.80 60909	1.916 83368	20.99 48852	14.65 02478	0.797 30953	17.25 70063	1.497 05033	16.96 70973	14.75 38008	0.782 06315	18.29 08420	0.472 77267 9	0.296 73102 1
1988	Chino ok_1	0.813 14557 9	0.717 14913 1	0.583 14664 9	0.078 16844 9	109.1 1	121.5 4	130.0 2	137.2 4	26.08 16869 8	20.30 97427	11.05 06102	137.8 52104 7	0.818 67880	12.50 89385	14.16 76728	8.335 81030	9.487 90092	57.70 13565	0.745 28790	10.25 38087	8.927 05540	19.00 72124	11.61 58671	176.9 80033	0.789 17757	12.94 03174	184.0 83862	0.881 26503	0.118 73496	0.775 41839	0.872 09178	0.916 74179	5.991 81656	20.59 59764	11.80 00120	0.836 21566	14.58 33997	2.314 11792	17.48 45341	12.03 02963	0.831 05156	14.70 46407	1.812 10906	14.08 07006	12.21 28238	0.832 81526	15.70 59054	0.647 48985	0.491 23197
1989	Chino ok_1	0.793 01275 4	0.514 83947 8	0.408 27427	0.429 49369	142.6 3	150.4 6	154.3 2	147.5 4	18.11 08414	27.78 49658	13.97 84188	193.1 41379	0.810 72034	13.83 30812	8.946 45943	13.65 88236	12.30 96036	76.66 09603	0.746 30048	11.40 03046	6.875 54882	25.52 71778	14.76 21388	256.8 66330	0.769 76383	14.23 87623	265.9 78027	0.367 63078	0.632 36921	0.605 10592	0.801 54891	0.860 11187	4.726 84262	27.60 99851	14.89 05138	0.797 60321	16.09 63977	1.742 97229	23.05 53068	14.98 06455	0.795 99742	16.52 29946	1.360 04863	18.65 95514	15.06 1378	0.780 09066	17.48 51570	0.521 97783	0.296 87016
1990	Chino ok_1	0.723 70507 4	0.328 63733	0.237 83650	0.366 53678	132.5 9	140.5 7	143.6 9	136.8 3	18.00 45313	26.45 66124	15.54 02851	170.4 29885	0.826 05867	13.33 02109	8.539 07776	13.85 68784	14.34 18029	61.70 34530	0.778 70645	10.88 26599	7.008 84015	24.16 86987	16.23 4025	228.2 34728	0.778 54842	13.75 87264	231.6 11709	0.309 22012	0.690 77987	0.436 25793	0.707 08202	0.779 99002	4.969 53018	25.81 76652	16.28 76876	0.812 87705	15.68 34703	1.865 53658	2.155 79811	16.28 75677	0.812 15341	15.99 09645	1.456 34402	17.43 57967	16.27 66637	0.804 37526	17.02 58760	0.390 20177	0.117 89470
1991	Chino ok_1	0.795 99972 7	0.605 04755	0.481 61768	0.261 85491	121.9 4	129.2 1	135.7	142.4 1	21.52 21889	24.06 08213	13.03 55471	194.9 82912	0.823 46942	13.98 71761	11.39 43275	10.33 03599	11.23 42165	62.03 22959	0.782 30412	11.00 81508	7.549 49552	22.72 39054	13.79 01406	260.9 83055	0.769 50862	14.38 43719	260.7 80609	0.595 12493	0.404 87506	0.680 19409	0.830 77255	0.882 70354	5.186 63723	24.52 00071	13.95 04154	0.797 92009	16.39 77138	1.947 23177	20.70 93938	14.14 68877	0.813 02646	16.83 91599	1.523 35692	16.67 90667	14.31 25386	0.807 08178	17.97 73440	0.556 85095	0.395 63362
1992	Chino ok_1	0.734 89145 2	0.495 64343	0.364 24412	0.222 46058	120.6 1	128.4 3	132.7 7	132.7 9	21.26 60822	23.15 00218	13.95 62895	161.2 66119	0.831 24002	13.15 17932	10.70 31915	11.08 39373	12.82 76348	50.74 97024	0.797 99016	10.89 84464	7.807 45935	21.56 35855	14.40 59705	219.6 81320	0.774 56834	13.52 08288	225.0 68206	0.583 53411	0.416 46588	0.599 90968	0.797 73573	0.856 05546	5.465 34562	23.10 32776	14.46 66517	0.814 57115	15.42 68278	2.079 46983	19.41 60488	14.57 94604	0.805 30067	15.76 31044	1.627 58126	15.63 08129	14.70 21637	0.793 06471	16.70 86167	0.457 13560	0.283 09527
1993	Chino ok_1	0.825 40552 7	0.722 41051	0.596 28163	0.483 46606	119.8	127.3 1	134.8 8	130.3 7	20.89 85031	24.07 47909	11.58 53768	212.3 45133	0.796 48802	14.38 76987	10.49 77946	11.88 12073	10.48 29845	87.47 25570	0.706 27884	11.27 17483	7.648 81990	23.01 53373	12.01 78764	273.7 56902	0.769 90662	15.03 07456	302.8 96728	0.406 05806	0.593 94194	0.780 09667	0.878 44613	0.922 81360	5.134 04605	25.03 57709	12.16 63129	0.798 98988	16.65 89830	1.873 82430	21.40 88924	12.30 38695	0.819 95592	17.11 03029	1.459 45195	17.39 84332	12.39 02940	0.815 54767	18.24 87621	0.654 81902	0.500 08090
1994	Chino ok_1	0.727 46872 4	0.438 08828	0.318 69552	0.393 19350	128.6 8	136.4 7	140.9 2	134.9 1	18.67 74982	25.93 80962	14.44 30644	169.9 15243	0.824 07344	13.23 71246	9.015 11869	13.29 41091	13.34 26679	63.18 88176	0.773 61280	10.79 80556	7.169 31127	23.79 65011	15.00 39030	226.2 10103	0.778 16081	13.69 03230	228.5 68847	0.350 99547	0.649 00452	0.554 95172	0.784 77818	0.846 46368	5.058 60374	25.47 87573	15.02 12219	0.812 78582	15.55 93305	1.893 90952	21.26 08779	15.03 75671	0.804 04881	15.88 04572	1.479 97541	17.16 08325	15.11 79060	0.791 15828	16.84 31873	0.403 28006	0.215 00853
1995	Chino ok_1	0.813 01790 3	0.632 31148	0.514 08055	0.498 42422	121.5 3	124.8 5	131.7	141.4 7	21.66 73214	23.64 42598	12.69 19698	193.9 38428	0.783 53431	13.71 38479	11.07 87493	11.20 28737	10.93 12078	88.85 02212	0.667 36438	10.83 72201	7.983 87894	21.27 29423	13.32 10221	240.1 29509	0.772 11026	14.24 08766	248.5 38009	0.356 20453	0.643 79546	0.703 70234	0.840 88786	0.891 18139	5.459 39764	22.95 48280	13.50 32722	0.805 44785	15.86 68836	2.073 69148	19.44 16967	13.76 83328	0.804 5	16.26 24686	1.620 99638	15.69 33248	14.00 52585	0.793 28069	17.41 06559	0.576 76754	0.447 54042
1996	Chino ok_1	0.777 95022 7	0.529 83792	0.412 18753	0.549 62309	137.6 7	136.4 2	139.9 7	152.1 6	16.26 80464	29.15 80841	14.48 32984	255.4 42006	0.794 67054	16.32 17714	7.393 32005	16.59 28492	13.45 07406	118.4 58644	0.692 17426	13.91 81369	6.602 85281	26.07 80871	14.80 07046	324.2 41946	0.777 41946	16.31 83140	331.9 92889	0.269 28740	0.730 71259	0.622 11391	0.809 82599	0.866 34957	4.636 40915	27.99 09199	14.91 60429	0.779 22793	18.22 53822	1.704 68296	23.53 40744	15.09 16436	0.809 59026	18.53 58880	1.328 20384	19.10 51270	15.26 95627	0.801 85177	19.91 77646	0.489 87766	0.317 42396
1997	Chino ok_1	0.822 81084 6	0.566 93685	0.466 48179	0.589 76523	133.5 5	136.6 7	138.9 3	140.4 2	14.57 35993	30.86 00633	14.02 33124	355.8 67755	0.810 37236	21.30 54114	6.218 79506	20.32 50378	12.57 09854	164.9 32803	0.696 52041	18.03 92543	5.884 48526	29.18 77208	14.60 32716	460.3 22703	0.810 43523	22.30 47890	468.0 05065	0.258 63463	0.741 36537	0.658 07125	0.829 60648	0.882 04305	4.132 02513	31.31 91949	14.71 41675	0.790 50085	24.46 09680	1.471 19428	27.24 37855	14.88 68398	0.858 83043	23.93 38792	1.144 85468	22.18 1308	15.06 55903	0.858 31213	24.48 39038	0.539 94882	0.389 54990
1998	Chino ok_1	0.830 11825 7	0.652 10351	0.541 32303	0.432 49766	114.8 6	122.2 8	129.2	130.1 2	21.83 10354	23.11 15192	12.48 78258	253.4 90760	0.791 40429	15.60 34640	11.24 86743	11.42 02813	10.34 32888	96.86 66534	0.695 25679	11.63 87613	7.675 33720	22.38 40727	13.31 52929	327.0 00269	0.767 22969	16.18 03356	347.3 63433	0.434 61532	0.565 38468	0.714 99466	0.842 42916	0.891 65540	5.267 50267	24.16 35507	13.53 92120	0.781 51649	1												

Columbia River System Operations Environmental Impact Statement
Appendix E: Fish, Aquatic Macroinvertebrates, and Aquatic Habitat

Year	Species	InRivSurvSNK	InRivSurvLCol	InRivSurv	ProportionTransported	MedDayLGR	MedDayConfl	MedDayBONinriv	MedDayBONtrans	meanTravelTime	meanMigRate	meanTemp	meanFlow	meanFSpill	meanGas	SNKTravelTime	SNKMigRate	SNKTemp	SNKFlow	SNKFSpill	SNKGas	LCTravelTime	LCMigRate	LCTemp	LCFlow	LCFSpill	LCGas	BonFlow	propBONinriv	propBONtrans	JDAInRivSurv	DeschInRivSurv	BONInRivSurv	JDATime	JDAMigRate	JDATemp	JDAFSpill	JDAGas	DESTime	DESMigRate	DESTemp	DESFSpill	DESGas	BONTTime	BONMigRate	BONTemp	BONFSpill	BONGas	monte_q975	monte_q025	
2003	Chino ok_1	0.799 48855 6	0.612 66401 5	0.489 81786 9	0.420 3032	129.6 7	135.7 1	142.7 1	141.0 1	19.45 76994 7	25.87 81542 4	13.18 78491 8	201.5 81975 7	0.807 10797 2	14.10 04781	9.732 66334 8	12.53 37361 2	11.71 67398 5	79.02 85339 4	0.733 77511 5	11.16 65611 3	7.287 06405 3	23.70 50544 8	13.82 20146 5	259.6 72894 8	0.771 77295 1	14.48 42426	283.3 67126 5	0.421 34256 7	0.578 65743 3	0.690 94747 3	0.838 83630 6	0.890 14835 1	5.006 41915 9	25.59 83006 9	13.95 19868 9	0.801 85816 3	16.28 59600 1	1.847 47407 6	21.68 73163 1	14.10 22227 6	0.809 1711	16.73 14717	1.437 35355 9	17.66 35154	14.23 27289 6	0.800 68191 9	17.92 30947 5	0.558 07013 6	0.405 63430 1	
2004	Chino ok_1	0.818 24218 3	0.654 70728 1	0.535 70911 5	0.117 23190 8	107.1 7	120.5 9	128.3 5	131.8 8	25.73 64403 2	20.65 50873 3	11.96 23210 1	173.8 48485 9	0.808 71566 3	13.08 87225	14.08 89075 5	8.922 49512 2	9.550 63095 1	61.94 46235 4	0.749 56426 6	10.31 71714 8	8.596 95603 3	19.76 90950 8	12.90 39437	226.0 52719 1	0.762 36670 2	13.63 84385 4	250.3 41186 5	0.813 53868 4	0.186 46131 6	0.720 10427 3	0.842 33158 4	0.891 70412 5	5.813 57289 9	21.38 95162 7	13.13 68942 3	0.803 75028 8	15.38 58659 7	2.215 86276 6	18.17 96488 2	13.47 64541	0.790 25854 7	15.78 95822 5	1.729 56459 2	14.73 09725 1	13.73 08397 3	0.771 69707 4	16.92 2122	0.616 65099 8	0.421 45466 5	
2005	Chino ok_1	0.779 11814 6	0.558 47935 9	0.435 12140 3	0.399 20314 2	120.8	127.5 1	133.9 1	135.6 9	20.84 54938 8	23.98 25095 9	13.72 40264 1	178.0 84131 5	0.811 05357 8	13.50 87078	10.46 73262 5	11.72 67378 6	12.21 38822 6	70.02 91809 1	0.739 39321	11.04 38404 1	7.747 84571 7	21.86 63407 9	14.28 02807 5	230.1 23036 7	0.776 29765 9	13.93 16856 1	241.6 35498	0.414 94489 9	0.585 05510 1	0.643 82422 7	0.811 04508 1	0.866 32314 9	5.387 30103 5	23.48 82354 8	14.43 06377 4	0.812 63297 8	15.64 43212 5	2.028 71171 4	19.84 00135 6	14.63 92742 8	0.804 77768 2	16.04 33718 4	1.583 86174 6	16.05 32642 7	15.83 43756 5	0.792 33476 5	17.08 89296 5	0.529 65539 5	0.330 96661 8	
2006	Chino ok_1	0.839 92162 7	0.713 61598 5	0.599 3815	0.569 56815 5	120.4 3	125.9 7	133.0 3	128.3 1	19.45 14725 4	24.55 93571 8	11.65 63386 9	241.2 18092 8	0.765 20325 9	15.36 32144 2	9.028 59111 9	14.69 27178 9	10.50 60176 8	127.3 45626 8	0.613 14146 5	13.21 37157 4	7.519 77479 5	23.00 61759 1	12.13 21986	304.1 58167 5	0.774 52309 9	15.72 80090	318.7 52471 9	0.326 58291 4	0.673 41708 6	0.771 06733	0.874 50535 5	0.919 88471 5	5.142 02630 5	24.87 59447 3	12.30 52183 2	0.784 96626 6	17.30 78386	1.906 63677 5	21.07 47896 8	12.44 55022 8	0.802 07457 1	17.57 13192 6	1.487 08877	17.07 88059	12.51 7313	0.788 30829 3	18.58 18214 4	0.677 47433 7	0.502 86719 7	
2007	Chino ok_1	0.787 44889 4	0.567 15129 5	0.446 60266	0.348 56979 5	120.1 8	127.3 5	132.9 9	130.4 5	20.79 38546 2	23.65 42571 1	13.54 04196 5	194.7 47821	0.819 23964 2	13.70 81028 7	10.44 65611 4	11.86 60003 1	12.07 29288 1	71.60 74157 7	0.766 36339 4	11.00 23700	7.551 70104 7	22.41 32240	14.15 72464 3	258.6 52066	0.772 92306	14.21 69185	267.0 88429	0.475 88429	0.524 11570	0.649 27260	0.816 04723	0.871 04484	5.274 04067	24.04 43725	14.29 27892	0.797 46086	16.13 45781	1.989 3694	20.23 22496	14.44 63609	0.793 02996	16.52 08514	1.553 44761	16.36 08882	14.55 68232	0.775 06333	17.56 38971	0.529 63019	0.350 79819	
2008	Chino ok_1	0.815 42277	0.723 82463	0.590 22308	0.180 86620 6	103.8 8	118.2 3	126.6	132.5 5	26.59 12621	19.94 97391 1	11.16 30574 6	156.9 28388 3	0.812 87727 6	13.04 59834 2	14.51 35091 8	8.786 91941 8	9.662 76378 6	64.03 55438 2	0.730 66245 3	10.34 84615 3	8.942 55826 6	18.80 15636 5	11.59 42506 8	196.1 27955 1	0.787 82900	13.50 30324	207.2 83371	0.744 24555	0.255 75445	0.777 65598	0.871 73478	0.916 03719	6.030 31585	20.33 17254	11.78 98206	0.830 84729	15.02 90805	2.335 55147	17.31 97265	12.09 43075	15.33 11613	1.828 50388	13.95 27595	12.36 95933	0.825 02170	16.55 81371	0.645 74207	0.498 26697	0.584 66431	
SCN MO1-RESSIM																																																			
1929	Chino ok_1	0.798 99170 4	0.640 58459 5	0.511 82177 8	0.340 13320 5	126.3 2	135.4 7	142.3 3	132.7	20.43 29002 9	24.64 89863 7	12.76 88157 2	137.5 73781 7	0.893 25109 5	13.41 98438 8	10.44 74514 9	11.79 98097 3	11.54 78351 6	60.80 05920 4	0.850 17180 4	11.26 72678	7.462 91371 4	22.32 50667 7	13.34 57020 1	177.5 18414 8	0.875 77625 1	14.11 16321 9	199.3 95507 8	0.518 50473 9	0.481 49526 1	0.704 27726 3	0.841 57372 5	0.891 61509 8	5.369 07883 7	23.68 82405	13.49 15199	0.876 99900	15.60 93410	2.000 95554	20.07 66871 8	13.58 61059	0.855 79524 4	15.89 57916	1.559 66251 3	16.29 77946	13.62 35885	0.852 60206	16.83 25223	0.589 34876	0.399 30724	
1930	Chino ok_1	0.809 16369 9	0.634 40168 5	0.513 33481	0.104 31137	103.5 9	117.9 2	125.3 5	140.3 6	25.19 65832 6	20.06 45649	12.08 39130	126.5 54277	0.910 61739	13.43 36452	13.48 86445	9.548 52846	10.00 54363	63.55 80856	0.871 81583	11.55 40725	8.541 99959	18.63 74566	12.77 97295	158.8 97692	0.898 26092	13.94 74629	165.9 7612	0.826 80038	0.173 19961	0.698 95497	0.829 59461	0.878 8999	6.227 27324	19.55 91130	12.98 29896	0.902 81717	15.52 67023	2.447 02227	16.58 40783	13.33 59734	0.887 60542	16.04 77078	1.919 33877	13.32 09901	13.64 36753	0.887 92064	17.22 20182	0.584 62355	0.414 33259	
1931	Chino ok_1	0.784 33555 8	0.607 17417	0.476 22829	0.074 60686	105.6 4	120.7 6	127.8 8	130.9 5	26.93 94422	19.69 72080	12.22 79278	116.5 35568	0.880 85352	12.90 16774	15.27 55572	8.093 37375	9.994 05288	44.05 95977	0.841 36508	11.39 5																														

Columbia River System Operations Environmental Impact Statement
Appendix E: Fish, Aquatic Macroinvertebrates, and Aquatic Habitat

Year	Species	InRivSurvSNK	InRivSurvLCol	InRivSurv	ProportionTransported	MedDayLGR	MedDayConfl	MedDayBONinriv	MedDayBONtrans	meanTravelTime	meanMigRate	meanTemp	meanFlow	meanFSpill	meanGas	SNKTravelTime	SNKMigRate	SNKTemp	SNKFlow	SNKFSpill	SNKGas	LCTravelTime	LCMigRate	LCTemp	LCFlow	LCFSpill	LCGas	BonFlow	propBONinriv	propBONtrans	JDAInRivSurv	DeschInRivSurv	BONInRivSurv	JDATime	JDAMigRate	JDATemp	JDAFSpill	JDAGas	DESTime	DESMigRate	DESTemp	DEFSpill	DESGas	BONTTime	BONMigRate	BONTemp	BONFSpill	BONGas	monte_q975	monte_q025	
1940	Chino ok_1	0.820 71190 7	0.724 92383 9	0.594 95362 7	0.065 05389	95.01	111.1 4	119.3 7	138.7	28.00 80522 1	18.50 42844	10.89 52482 1	166.5 34957 9	0.857 00230 1	13.61 74889 6	15.54 35049 3	9.299 90026 4	9.240 03448 5	81.62 60864	0.752 63247 5	10.60 60083	8.744 52811 5	18.20 14546	11.35 05428 6	208.7 55521 1	0.872 47854 5	14.54 38862 6	218.8 68347 2	0.902 30512 3	0.097 69487 7	0.774 86070 1	0.867 88490 2	0.912 24921	6.336 40271 4	19.14 47349	11.55 78315 7	0.863 29512 6	16.18 43593	2.494 84345 3	16.27 56418 8	11.89 23835 8	0.841 24535 3	16.66 33230 8	1.957 35171 4	13.06 91954 2	12.17 30938	0.835 31910 2	17.68 49613 2	0.648 70289	0.495 02706 7	
1941	Chino ok_1	0.749 14818 9	0.474 54503 6	0.545 50455 4	0.284 22035 3	132.7 5	138.2 3	138.7 2	142.3 6	19.43 79004 9	25.20 88991 8	14.53 42861 6	145.6 55464 4	0.895 16841 9	13.55 36211 2	9.679 38191	12.61 05317 5	13.32 58932 1	59.29 86152 6	0.866 56682 5	11.53 92927 2	7.285 61043 7	22.46 03926 3	15.03 33499 9	190.2 50544 2	0.866 58773 8	13.91 62191 5	197.4 86312 9	0.498 23126 5	0.501 76873 5	0.569 62453 6	0.775 45659 1	0.836 09838 4	5.348 77193	23.59 92024 3	15.10 57928 1	0.861 19735 2	15.64 43040 8	2.033 83436 8	19.82 05386 1	15.23 68129 1	0.844 71414 5	15.91 74388 2	1.589 98161 6	15.99 32565 1	15.36 71870 2	0.843 42995 3	16.87 03274 7	0.447 52662 4	0.262 11503 2	
1942	Chino ok_1	0.811 70848 3	0.667 74256 2	0.542 01230 2	0.516 59634 1	133.7 2	136.6 8	142.5 3	146.1 6	19.65 27019 7	25.75 03714 6	12.63 03714 6	185.8 55464 4	0.836 50137 3	13.88 36839 5	9.968 88828 3	12.39 32848	11.32 06394 2	84.66 63360 6	0.748 01766 9	11.24 59102 6	7.299 26621 9	22.94 60613 7	13.07 50408 2	233.8 47071 3	0.828 48885 7	14.40 68624 2	242.6 61224 4	0.352 46705	0.647 53295	0.729 33467 2	0.853 90398 8	0.902 41305 2	5.181 76949	5.348 80953 5	23.59 92024 3	15.10 57928 1	0.861 19735 2	15.64 43040 8	2.033 83436 8	19.82 05386 1	15.23 68129 1	0.844 71414 5	15.91 74388 2	1.589 98161 6	15.99 32565 1	15.36 71870 2	0.843 42995 3	16.87 03274 7	0.447 52662 4	0.262 11503 2
1943	Chino ok_1	0.834 77076 5	0.688 26635 1	0.574 54462 8	0.417 36215 2	120.7 7	123.7 2	129.0 5	130.2 5	21.43 32939 5	23.19 28733 9	11.87 17716	229.5 36246	0.805 56233 9	15.40 98134 4	10.74 78905	13.12 25317	10.41 97734 8	118.3 48120 1	0.683 01384 4	13.41 20355 2	7.708 61249 4	21.67 50815	12.36 67254 4	291.0 44362	0.810 46831 6	15.55 40009	304.6 50116	0.459 96393	0.540 03606	0.743 22444	0.856 73282	0.904 25633 6	5.456 65579	23.12 60548	12.56 31456	0.796 09700	17.28 84456	2.060 99789	19.55 11546	12.78 76215	0.811 94484 2	17.54 53319 5	1.610 49210	15.79 20558	12.97 26638	0.805 91714	18.63 35773	0.658 13162	0.480 17721	0.340 87437
1944	Chino ok_1	0.792 55436 1	0.585 00774 3	0.463 65043 8	0.412 84411 6	130.5 7	138.1 9	144.9 6	139.1 1	19.67 26621 5	25.34 45619 6	13.43 20886	133.6 89637	0.867 83611 3	13.01 05225	9.808 89131	12.12 85457	12.01 98164	66.29 36607	0.817 61344	11.45 64792	7.492 10833	22.07 09892	14.03 14377	167.5 90665	0.843 60676	13.18 38274	170.7 64831	0.417 08386	0.582 91613	0.654 84578	0.813 78211	0.867 27770	5.401 72694	23.37 82229	14.19 04192	0.849 69406	14.62 51483	2.054 99379	19.62 95258	14.35 83758	0.843 72495	14.75 56193	1.607 28131	15.82 51687	14.50 31805	0.845 77098	15.72 89485	0.560 40106	0.340 87437	
1945	Chino ok_1	0.815 31164 2	0.673 60975 5	0.549 20187 5	0.448 58486 9	117.8 4	125.8	132.8 9	130.3 1	21.76 61102	23.27 90872	12.26 38592	175.8 02066	0.847 23151	13.86 44582	11.30 61825	11.41 85748	10.70 72275	76.24 81704	0.780 38382	11.58 51894	7.688 29067	21.71 12319	12.83 65205	223.0 30586	0.826 55406	14.29 01635	238.9 43512	0.422 03649	0.577 96350	0.732 41740	0.850 02346	0.898 13212	5.476 29531	23.11 73329	13.02 93211	0.822 30770	15.77 61400	2.058 09640	19.55 84026	13.27 26570	0.810 85856	16.11 65771	1.606 71522	15.82 91762	13.45 22814	0.801 75969	17.13 50016	0.618 23823	0.451 40067	
1946	Chino ok_1	0.856 54332 3	0.745 25263 7	0.638 34117	0.202 65909	111.3 6	120.2	127.7 4	127.0 4	21.69 44866	22.94 58805	11.18 10024	258.2 99548	0.801 34776	15.94 82754	10.83 41563	9.587 07809	119.3 49964	0.700 56008	13.24 84716	7.756 74792	21.92 74154	11.68 90071	328.6 80501	0.786 01169	16.16 31305	342.9 23339	0.730 33432	0.269 66567	0.792 30426	0.877 67713	0.921 37503	5.415 85597	23.53 85597	11.90 9869	0.766 84142	17.92 88085	2.017 64244	19.93 68246	12.19 01966	0.793 87547	18.13 31558	1.574 52393	16.14 49226	12.39 02421	0.800 14574	0.698 23403	0.543 95049			
1947	Chino ok_1	0.835 04541	0.645 13684	0.538 71856	0.264 86899	110.4 5	121.0 8	128.2 3	128.4	22.25 05635	22.80 44915	12.43 39355	239.2 28252	0.813 75565	14.83 06481	11.57 65881	11.86 95249	10.05 04821	95.47 76199	0.733 33289	11.22 75844	7.676 09056	21.96 00640	13.36 15117	306.1 16923	0.787 65296	15.39 35913	329.7 93853	0.619 47952	0.380 52047	0.709 27450	0.836 73471	0.886 97329	5.417 82626	23.47 60892	13.59 27679	0.779 13202	17.20 82271	2.013 64070	19.95 66790	13.93 46129	0.801 03617	17.92 23467	1.569 99856	16.19 09454	14.19 52447	0.794 90891	19.18 22748	0.621 93293	0.425 31490	
1948	Chino ok_1	0.829 75911	0.617 92337	0.512 72754	0.527 38881	132.2 1	136.8	140.5 5	141.3 7	15.56 33769	29.85 76169	13.53 39360	328.8 39012	0.834 60824	19.55 33534	7.124 93357	17.49 52166	12.17 01505	142.6 00729	0.758 52565	16.20 46463	6.022 16403	28.63 16753	14.07 02621	425.1 73334	0.815 31494	20.59 29384	447.9 06005	0.330 72170	0.669 27829	0.697 65546	0.843 19390	0.893 35038	4.221 21291	30.75 17271	14.20 21961	0.796 30547	22.90 03242	1.512 27038	26.51 14264	14.37 70767	0.834 31164	22.69 28424	1.177 33132	21.56 60245	14.53 60245	0.830 92361	22.77 13308	0.587 06025	0.430 27397	
1949	Chino ok_1	0.809 12085	0.564 20305	0.456 50845	0.597 18651	126.5	132.3 9	137.6 1	132.9 4	16.47 35761	28.00 39938	13.78 62197	271.9 92415	0.797 51411	16.53 31736	7.379 79762	17.27 90865	12.37 18332	125.6 82060	0.694 21107	13.94 41776	6.457 44054	26.67 33049	14.45 17863	348.1 16790	0.782 35737	16.66 25360	377.7 5354	0.250 02743	0.749 97256	0.657 08365	0.825 30401	0.879 29692	4.596 38290	28.51 81545	14.53 74958	0.764 87041	18.44 16889	1.642 52953	24.35 66396	14.63 73119	0.817 99320	18.73 79360	1.276 43780	19.87 94342	14.73 65789	0.820 28096	19.97 73893	0.537 36127	0.347 28887	
1950	Chino ok_1	0.818 39159	0.674 27649	0.551 82221	0.533 90218	130.9 4	136	141.8 3	139.6 2	18.63 23579	26.66 91076	12.69 18921	213.0 90675	0.831 39022	14.47 92749	9.262 95809	13.61 84508	11.43 87630	92.44 73190	0.752 70041	11.96 76473	6.931 81026	24.64 55881	13.17 45214	273.4 02359	14.86 66061	0.812 20204	0.340 69647	0.659 15375	0.735 13624	0.856 37328	0.904 78272	4.899 33121	26.37 92287	13.34 57214	0.803 19528	16.67 88385	1.803 84209	22.23 98478	13.51 73705	0.806 87212	17.11 19092	1.405 21553	18.06 36261	13.63 93746	0.793 37230	18.22 81770	0.636 31995	0.445 58341		
1951	Chino ok_1	0.824 74622	0.635 40018	0.524 04390	0.537 33524	130.5	134.4 8	139.7 1	137.6 6	18.06 48568	26.94 45211	13.20 42586	259.7 42085	0.809 19483	15.95 82430	8.823 71583	14.52 69989	11.60 64243	106.6 15655	0.730 50708	12.84 57202	6.709 52276	25.49 72969	13.83 56073	337.4 80326	0.779 36558	16.20 78077	0.326 13831	0.673 86168	0.701 37327	0.838 91236	0.889 86056	4.735 98567	27.30 58427	14.01 59057	0.762 62136	18.17 87838	1.738 38315	23.08 95543	14.22 74419	0.802 77419	18.50 66076	1.355 05396	18.72 77680	14.39 96138	0.803 49624	19.76 60570	0.598 43029	0.435 78461		
1952	Chino ok_1	0.854 38296	0.730 34382	0.623 99332	0.575 71850	123.6	123.2 6	130.3 9	133.3 1	17.93 61870	26.16 82008	11.73 52292	288.9 92601	0.780 79001	17.86 75852	7.959 83628	16.94 12533	10.50 70592	161.6 88269	0.655 19927	16.77 93685	7.214 90953	23.76 44755	12.10 23243	355.1 10366	0.775 84434	17.21 00742	366.1 55151	0.328 56061	0.671 43938	0.781 41418	0.875 42639	0.920 53954	5.028 36535	25.54 70487	12.30 87814	0.754 4765	18.68 85133	1.856 30235	21.64 6927	12.52 53063	0.803 61330	18.85 05923	1.448 09392	17.53 32908	12.69 93746	0.811 9075	20.00 51269	0.683 91913	0.531 18672	
1953	Chino ok_1	0.819 15018	0.665 10560	0.544 82137	0.439 54909	131.8 2	133.5 3	140.2 1	143.3	20.08 64096	25.29 24635	12.67 78335	207.0 56004	0.835 79232	14.46 55892	10.42 22599	11.96 31695	11.08 07500	85.75 77789	0.763 48787	11.59 17821	7.155 38727	23.54 77807	13.30 13580	264.6 03187	0.813 94265	14.91 68982	279.3 69354	0.427 77573	0.572 22426	0.725 95367	0.849 88573	0.898 																		

Columbia River System Operations Environmental Impact Statement
Appendix E: Fish, Aquatic Macroinvertebrates, and Aquatic Habitat

Year	Species	InRivSurvSNK	InRivSurvLCol	InRivSurv	ProportionTransported	MedDayLGR	MedDayConfl	MedDayBONinriv	MedDayBONtrans	meanTravelTime	meanMigRate	meanTemp	meanFlow	meanFSpill	meanGas	SNKTravelTime	SNKMigRate	SNKTemp	SNKFlow	SNKFSpill	SNKGas	LCTravelTime	LCMigRate	LCTemp	LCFlow	LCFSpill	LCGas	BonFlow	propBONinriv	propBONtrans	JDAInRivSurv	DeschInRivSurv	BONInRivSurv	JDATime	JDAMigRate	JDATemp	JDAFSpill	JDAGas	DESTime	DESMigRate	DESTemp	DESFSpill	DESGas	BONTTime	BONMigRate	BONTemp	BONFSpill	BONGas	monte_q975	monte_q025
1958	Chino ok_1	0.830 32455 9	0.655 29122 4	0.544 10439 7	0.543 67991 8	124.9 8	130.7	136.6 5	137.0 4	16.85 35738 6	28.30 01024 3	12.85 15801 4	273.5 97718 4	0.834 65301 1	17.09 10854 3	7.933 76744 5	15.98 54874 5	11.50 95497 1	122.1 03903 2	0.778 08044	14.72 42023 5	6.424 53866 5	27.08 36357	13.42 99704 2	349.5 56304 9	0.799 12342 6	17.08 29000 5	370.5 07934 6	0.329 72581 5	0.670 27418 5	0.727 95346 2	0.854 63283 2	0.903 60001 1	4.531 68254 3	29.06 91775 9	13.57 20594 4	0.775 52498 6	18.90 80326 1	1.622 83989	24.67 11898 4	13.71 14814 1	0.814 48147 7	19.25 60265 9	1.262 05053 2	20.10 64803 3	13.79 89087 1	0.813 94809 5	20.44 26975 3	0.609 72664 7	0.460 02898 4
1959	Chino ok_1	0.806 44149 9	0.576 41457 3	0.444 84463 2	0.442 86355 6	136.3 7	142.8 3	146.3 4	142.7 9	17.96 72399 5	27.71 12999 8	13.72 73289 1	228.0 28760 1	0.846 74139 1	14.88 63440 6	9.082 18991	13.72 60907 8	12.08 90504 8	83.26 85165 4	0.809 54300 7	11.77 64091 5	6.507 85294 9	26.32 57398 4	14.48 57999 5	305.2 88508 1	0.801 11090 3	15.47 22413 2	318.4 58435 1	0.387 08049 2	0.612 91950 8	0.655 77856 2	0.821 94276 7	0.876 69798 2	4.618 02545 9	28.15 42037 6	14.61 5135	0.784 07872 9	17.56 59395 2	1.693 03376 2	23.69 38038 5	14.74 96611 3	0.799 06044 4	17.80 67674 6	1.319 02626 9	19.23 76901 7	14.84 72385 4	0.794 37393 5	18.76 18236 5	0.553 05255 5	0.360 67655 7
1960	Chino ok_1	0.809 21649 1	0.646 22706 5	0.522 93759 8	0.504 42823 4	132.1 5	137.5 3	142.0 9	140.5	19.10 08188 5	26.45 60909 5	12.98 46140 3	205.3 47655 2	0.837 49683 4	14.16 15155 4	9.770 65661 5	12.76 43582 6	11.46 46652 2	81.78 30932 6	0.770 60334 7	11.38 82858 3	6.916 90845	24.59 89977 6	13.53 34687 2	267.8 48447 2	0.811 99016 2	14.62 35638 5	281.9 97802	0.354 34736 4	0.645 65263 6	0.711 97555 8	0.846 87946 7	0.896 69775 1	4.908 41693 4	26.28 51565 7	16.57 51855 9	1.812 37856 3	22.14 53892 2	13.90 45976 5	0.803 57839 7	16.96 35267 3	1.412 44215 5	17.97 20350 1	20.35 22226 9	14.09 72648 9	0.791 45509 4	18.03 92036 2	0.603 07126 3	0.426 87822 6	
1961	Chino ok_1	0.800 64403 3	0.630 87483 2	0.505 10617 2	0.230 18175 2	118.6 4	127.6 7	134.5 3	132.6	21.82 47657 1	23.37 68231 2	12.78 72288 6	192.5 68783 1	0.855 59152 7	13.96 45372 5	11.68 08888 8	10.43 83561 4	10.95 02586 4	61.95 19004 8	0.821 58224 6	11.00 49619 7	7.393 87480 2	22.57 43515 4	13.58 66018 9	256.6 63813 3	0.811 72843 3	14.39 93567 6	266.7 9422	0.647 23803 9	0.352 76196 1	0.696 83485 7	0.836 67459 7	0.887 72011 6	5.289 30751 3	24.00 32003 3	13.75 14881 8	0.803 14496 8	16.41 30512 2	1.978 67814 5	20.34 96398 9	13.93 53682 2	0.808 16000 7	16.78 84445 3	1.545 71566 7	16.44 13687 6	14.08 18605 4	0.803 47979 3	17.86 37037 3	0.579 2849	0.416 86573 7
1962	Chino ok_1	0.830 94620 1	0.678 30318 2	0.563 63345 2	0.317 59565 8	119.5 2	127.1 6	133.7 7	131.3 8	20.12 02709 9	24.07 20274 5	12.31 95427 5	192.2 58015 8	0.857 89889 1	14.21 73426 5	9.905 91778 6	12.67 44084 2	10.78 24852	87.12 95059 2	0.807 01761 2	11.95 48389 4	7.451 33614 5	22.44 47600 7	12.86 55592 6	249.0 60447 7	0.829 24968	14.67 71183	252.8 31878	0.567 10946	0.432 89054	0.734 13905	0.850 58037	0.898 67497 4	5.351 66907 3	23.84 04883 7	13.07 95066 8	0.811 42714	16.48 87586	2.009 50676 2	20.06 58240	13.33 26606	0.799 98811	16.66 83136	1.571 55820	16.17 59820	13.51 72648	0.788 54998	17.65 37237	0.649 89098	0.461 54463
1963	Chino ok_1	0.809 38371 5	0.616 84166 6	0.499 26159 9	0.356 74712 1	117.1 7	125.3	132.1 4	131.6 8	22.39 38931 7	22.64 10412 7	12.78 83232	164.0 60980 7	0.849 08688 5	13.40 48016 8	11.75 95105 3	10.79 17280 7	10.83 06045 5	71.57 80242 9	0.775 84741 1	10.80 66677 1	7.840 03458 2	20.93 08606 4	13.56 88039 5	208.2 24751 8	0.834 66338 1	13.97 14102	216.3 61511 2	0.493 66440 8	0.506 33559	0.682 33551	0.827 13978	0.879 01598	5.652 15406	22.14 85251 4	13.75 48532 5	0.833 71607 1	15.54 50223	2.153 64629	18.74 95356	0.826 41091	15.91 67585	1.685 47551	15.10 14079	14.19 96217	0.823 37317	16.96 17486	0.575 77696	0.412 24746	
1964	Chino ok_1	0.819 17892 6	0.612 47879 8	0.501 72972 4	0.624 09064 5	133.0 8	139.6	145.2 1	141.7 3	17.35 86934 5	28.35 90901 8	13.46 07236	225.8 37675 4	0.819 68859 7	15.01 67227 5	8.451 96916 9	15.11 40444 8	11.82 53685	103.9 83528 1	0.727 17528 3	12.65 05704 9	6.577 90429 1	26.12 64115	14.13 99507	288.4 31981	0.806 62767	0.683 60916	0.832 22776	0.884 19736	4.648 81927	27.98 49474	14.30 62482	0.798 03780	17.07 61388	1.706 37856	23.52 58240	14.48 26606	0.815 98811	17.56 83136	1.329 55820	19.08 59820	14.63 72648	0.805 54998	18.62 37237	0.596 89584	0.377 18214				
1965	Chino ok_1	0.791 21155 6	0.534 43962 4	0.422 85480 7	0.646 19143 4	142.7 6	140.7 8	140.9 2	152.0 2	15.74 91483 2	29.71 39269 7	14.15 47100	255.2 52221	0.790 65922	16.31 13710	6.923 92658	18.56 80140	12.93 75961	136.7 97723	0.669 48521	14.53 13720	6.504 84456	26.31 81570	14.55 37737	321.1 13357	0.786 96720	16.27 75397	326.4 17877	0.200 49778	0.799 50221	0.637 42158	0.821 53595	0.875 96804	4.622 62239	28.13 12181	14.63 67263	0.768 17847	17.94 90926	1.701 36108	23.62 53955	14.83 53160	0.801 37256	18.06 69686	1.327 96003	19.10 85997	15.08 50510	0.796 38397	19.19 89517	0.492 59214	0.345 01853
1966	Chino ok_1	0.809 50775 3	0.697 80009 2	0.564 53601 5	0.133 16821 8	111.4 5	123.0 6	130.3 4	132.2 9	23.29 96475	21.70 26463	11.66 80686	159.8 15138	0.902 23544	13.80 69184	12.36 71194	9.915 52664	10.34 06595	60.26 8853	0.893 94478	11.88 16902	8.016 10190	20.42 75350	12.11 12786	207.7 49463	0.860 26255	14.06 46286	219.4 62463	0.801 44091	0.198 55908	0.755 83452	0.865 53660	0.911 69680	5.760 88101	21.63 31734	12.28 12778	0.852 79967	15.93 6166	2.200 20685	18.34 64911	12.48 91703	0.832 88969	16.37 68224	1.720 60666	14.80 61263	12.66 33892	0.822 85940	17.47 92928	0.635 58781	0.475 03330
1967	Chino ok_1	0.813 35515 2	0.716 79346 7	0.583 00765 9	0.335 82984 5	125.3 7	133.7 6	140.3 2	136.0 4	20.55 05873	25.32 40935	11.99 49058	200.2 43349	0.871 35555	14.46 31855	11.02 43948	11.06 51845	10.84 35155	66.52 45025	0.854 13541	11.57 37346	7.022 41087	24.32 39142	12.42 39794	266.3 10371	0.821 38354	14.91 61807	282.6 84753	0.555 65129	0.444 34870	0.770 47273	0.872 41915	0.917 90984	4.951 20787	26.05 29639	12.58 34171	0.807 90283	16.82 26247	1.817 19040	22.08 86894	12.73 72789	0.814 80199	17.15 10343	1.416 29570	17.92 34293	12.85 19864	0.817 09840	18.13 00520	0.642 51128	0.485 13251
1968	Chino ok_1	0.727 19167 6	0.438 14981 4	0.318 61889 7	0.438 98248 9	138.7 4	141.9 4	143.1 6	149	17.73 70608 7	27.46 292	15.13 11406	174.9 94009	0.859 61788	13.65 64081	8.576 51127	14.08 56605	14.15 38621	69.56 83761	0.809 64548	11.22 61405	6.916 95399	23.86 42652	15.45 64596	32.75 32758	0.831 07069	14.03 46088	231.6 48742	0.311 11806	0.688 88193	0.551 38429	0.778 07472	0.839 61947	5.038 94062	25.17 94062	0.828 92785	15.85 40952	1.898 07973	21.16 85139	15.61 18596	0.825 54912	16.16 46445	1.480 30822	17.15 75921	15.79 57196	0.815 66613	17.33 25324	0.422 99721	0.217 20225	
1969	Chino ok_1	0.839 94563 4	0.656 09800 8	0.551 08665 8	0.357 38631 8	116.3 9	122.7 7	129.9	132.4 3	20.57 06764 8	23.77 60493 3	12.51 83185	249.4 60933	0.795 60459	15.56 96079	10.16 97840	12.97 50642	10.46 15263	110.9 16835	0.689 64320	12.87 80307	7.514 71139	22.48 06593	13.32 13631	315.6 60100	0.781 70814	15.68 03940	325.0 98877	0.516 35738	0.483 64261	0.716 07409	0.841 49106	0.891 35064	5.297 71186	24.04 72731	13.55 84852	0.771 35679	17.53 58432	1.968 41789	20.44 30275	13.84 72058	0.800 70968	18.13 21042	1.536 93001	16.53 33220	14.05 81984	0.790 59064	19.45 54548	0.621 20414	0.451 45758
1970	Chino ok_1	0.817 87541 7	0.693 91498 9	0.567 53601 1	0.469 06479 3	123.1 7	127.8 8	134.9 8	142.1 6	20.79 28313	24.35 21425	12.16 96149	180.5 37498	0.865 01499	14.51 56249	10.69 81464	11.16 91736	10.75 83055	84.21 23718	0.807 09372	12.61 99773	7.602 20677	21.85 5012	12.64 48966	219.3 78237	0.845 79036	14.57 67128	224.3 56201	0.408 61424	0.591 38575	0.752 51815	0.861 95923	0.908 48184	5.414 46835	23.25 63923	12.82 12778	0.843 24344	16.18 16738	2.044 26003	19.71 57950	13.05 84373	0.839 24025	16.63 95168	1.597 78986	15.91 66771	13.24 98107	0.834 57467	17.89 08414	0.622 8	0.490 98987
1971	Chino ok_1	0.836 66253 2	0.600 2969	0.502 24592	0.642 44478	138.9	145.4 9	147.5 9	143.0 7	14.23 72299	32.27 67620	13.72 56026	327.6 70737	0.807 53221	19.51 08181	6.257 73555	20.25 24649	12.																																

Columbia River System Operations Environmental Impact Statement
Appendix E: Fish, Aquatic Macroinvertebrates, and Aquatic Habitat

Year	Species	InRivSurvSNK	InRivSurvLCol	InRivSurv	ProportionTransported	MedDayLGR	MedDayConfl	MedDayBONinriv	MedDayBONtrans	meanTravelTime	meanMigRate	meanTemp	meanFlow	meanFSpill	meanGas	SNKTravelTime	SNKMigRate	SNKTemp	SNKFlow	SNKFSpill	SNKGas	LCTravelTime	LCMigRate	LCTemp	LCFlow	LCFSpill	LCGas	BonFlow	propBONinriv	propBONtrans	JDAInRivSurv	DeschInRivSurv	BONInRivSurv	JDATime	JDAMigRate	JDATemp	JDAFSpill	JDAGas	DESTime	DESMigRate	DESTemp	DEFSpill	DESGas	BONTTime	BONMigRate	BONTemp	BONFSpill	BONGas	monte_q975	monte_q025			
1976	Chino ok_1	0.849 97928 8	0.738 99613 3	0.628 13140 7	0.511 22029 3	119.8 2	125.2	132.2 1	130.8 5	19.15 94920 1	25.09 1209	11.57 58348 2	262.2 89676 7	0.815 68755	16.26 98787	9.169 80471 5	14.33 08383 6	10.25 24753 6	122.4 24229 4	0.725 23702 4	13.56 30983	7.183 31566 5	23.79 29019 6	12.05 21302 2	331.6 44521 1	0.798 90678 3	16.54 17728 4	344.7 33276 4	0.391 17207 7	0.608 82792 3	0.787 55675 6	0.877 65611 5	0.922 21834 5	5.043 35609	25.51 64997 8	12.25 99752 4	0.776 33259 3	18.29 16313 2	1.847 64793 5	21.73 78001	12.45 92752 5	0.806 16396 7	18.54 29770 2	1.440 74532 4	17.62 16648 3	12.59 20109 7	0.808 27587 8	19.65 97709 7	0.687 59938 3	0.548 50999 4			
1977	Chino ok_1	0.730 52956 2	0.507 41033 9	0.370 67825 3	0.149 97339 7	131.2 8	140.4 3	146.1 6	134.0 5	21.08 48832 5	23.86 06114 6	14.06 49781 2	106.2 07985 2	0.915 47644 6	12.80 59308 9	10.91 94600 1	10.71 28356 6	12.90 73389 1	0.890 01893 6	11.18 32063 7	7.672 40389 4	21.09 49253 4	14.60 27588 8	141.5 41753 1	0.893 85494 6	13.12 45815	147.5 94101	0.701 10041 8	0.298 89958 2	0.592 26477 7	0.783 19897 9	0.841 43561 4	5.632 98543 5	22.12 93065	14.67 84456 3	0.903 02624 7	14.86 95619 6	2.167 42479 1	18.63 20553 2	14.77 00700 8	0.888 98891 2	15.17 83870 1	1.695 85528 2	15.01 79636 8	14.85 03975 9	0.890 87984 5	16.31 49652 5	0.468 86578 5	0.280 23339 5				
1978	Chino ok_1	0.842 22999	0.738 08009 9	0.621 63319 5	0.220 38437 6	109.6 2	120.0 5	127.6 6	128.4 2	23.47 59070 1	21.78 46818 1	11.12 03789	202.9 37811 2	0.853 08755 7	14.49 67962 7	12.40 09707 5	11.28 21124 9	9.563 56048 6	91.55 38040 2	0.793 48548 7	12.06 07198	7.991 46401 1	20.65 94650 7	11.66 67634 6	260.3 81228 1	0.829 30026 5	14.98 48915 7	270.4 83947 8	0.703 82703 2	0.296 17296 8	0.786 17825 3	0.877 63478 9	0.922 08513 5	5.691 58303	21.96 74119 6	11.86 26201 6	0.812 64766 5	16.73 74635 7	2.170 18052 2	18.59 40724 1	12.09 35961 4	0.798 76313 6	16.93 48605 5	1.696 97081 3	15.00 58066 4	12.28 28278 5	0.789 32532 7	17.85 15157 2	0.678 23129 2	0.532 42188 7			
1979	Chino ok_1	0.829 90881	0.729 85595 7	0.605 71388 9	0.205 82795 2	113.3 2	123.2 4	130.7 6	127.4 4	23.65 01840 7	21.92 44346 2	11.25 23232 3	182.4 69430 2	0.833 98533 3	13.37 31627 3	12.67 77860 7	10.38 75045 9	9.631 55002 6	72.55 85189 8	0.768 37824 6	10.39 99925 6	7.999 17555 6	20.96 42391 5	11.86 99272 3	237.5 98716 7	0.805 65119 8	14.09 09310	249.4 87930 3	0.720 23965 3	0.279 76034 7	0.780 27867 7	0.873 81245 1	0.918 72490 1	5.616 31394 3	22.43 14817 9	12.07 45597 8	0.803 20012 6	15.67 43963 2	2.124 89790 5	18.98 51915 3	12.30 07745 7	0.800 46647 8	16.10 36287 9	1.661 56829 1	15.31 77176 7	12.45 98593 5	0.787 11217 6	17.17 08645 8	0.678 27151 8	0.498 12641 1			
1980	Chino ok_1	0.827 66862 5	0.619 15902 4	0.512 45849 1	0.567 38304 1	134.2 1	136.6 4	142.0 5	146.9 1	16.54 18897	29.11 29226 9	13.43 96556 6	254.3 33659 6	0.817 27188 8	16.03 47151 4	7.800 64870 4	16.24 11022 6	11.85 74585	110.6 0740	0.740 79221 5	13.27 20615	6.385 42689 4	27.25 08006	14.17 76590 3	333.0 68456	0.789 64122 5	16.43 58460	339.2 33551	0.295 44189 9	0.704 55810 6	0.688 67356 7	0.834 33996 3	0.886 23026 5	4.508 78430	29.24 01313 2	14.33 71730 8	0.772 97402 6	18.35 48408	1.635 12350 6	24.53 08631 7	14.48 10702	0.803 23616	18.53 64290	1.273 81272	19.92 03797	15.43 87730	1.648 96319	0.810 39972	16.38 63598	0.797 64375	19.60 14137	0.583 76148	0.428 19278
1981	Chino ok_1	0.780 17620 2	0.571 57214 8	0.445 92698 7	0.389 16479 3	124.4 1	124.0 6	129.0 6	148.3 1	21.25 24284	23.61 55507	13.59 43987	188.5 11274	0.836 82548	14.02 16704	10.98 40227	11.54 01891	12.20 23164	78.79 60998	0.764 55390	11.41 30119	7.605 68852	21.46 93537	13.98 38724	238.8 12571	0.815 46516	14.32 77240	244.2 40890	0.433 36705	0.566 63294	0.652 80097	0.818 73219	0.873 19336	5.479 11471	22.70 91381	14.11 71737	0.809 56295	15.99 21176	2.106 62860	19.16 12727	0.810 48739	16.38 97726	1.648 19427	15.43 96319	14.60 39972	0.805 63598	17.53 75642	0.528 21894	0.358 76525				
1982	Chino ok_1	0.813 46789	0.527 58982 8	0.429 17738 4	0.591 29021 3	143.1 1	146.4 7	144.8 7	149.2 6	15.48 52797	30.44 55807	14.47 99351	271.3 66021	0.813 97435	16.99 03809	7.070 25060	18.02 89468	13.14 29212	128.4 20961	0.733 60776	14.58 03798	6.129 2805	23.05 01535	15.06 54880	346.4 86282	0.787 93395	17.11 13084	346.9 67071	0.242 20471	0.757 79528	0.615 50001	0.803 02639	0.860 33399	4.353 01476	30.00 46362	15.18 24022	0.764 11855	18.85 01705	1.587 21684	25.30 39029	15.31 37277	0.812 84558	18.99 05084	1.237 91488	20.49 97544	15.43 39633	0.811 57654	20.28 76148	0.527 64848	0.322 43719			
1983	Chino ok_1	0.822 54519	0.631 60851	0.519 52654	0.440 89552	118.9 1	124.3	131.0 7	143.2 8	20.15 15450	24.75 14969	12.92 70932	217.5 50379	0.815 49798	14.55 04681	10.12 11040	12.82 52472	11.02 84145	100.3 15969	0.724 73355	11.78 17981	7.413 38126	22.61 77416	13.63 38302	277.0 96684	0.798 88410	15.00 23088	283.3 16223	0.414 67083	0.585 32917	0.696 55388	0.833 93132	0.885 10132	5.270 03972	24.11 10963	13.83 64587	0.788 94828	16.74 16616	1.977 68412	20.37 25779	14.11 46278	0.797 48030	17.13 68408	1.545 78836	16.44 09928	14.34 51867	0.783 72335	18.33 29992	0.586 83335	0.442 83722			
1984	Chino ok_1	0.821 19127	0.600 96367	0.493 50613	0.582 36537	128.3 3	133.7 7	139.1 4	138.0 4	16.69 88507	27.85 76934	13.49 02097	223.5 75364	0.823 92566	15.49 18092	7.480 28136	16.53 24908	12.19 77045	122.2 91641	0.731 68945	13.95 54817	6.756 47056	25.25 70404	13.99 42838	275.3 91433	0.812 75210	15.47 47662	282.9 37194	0.275 80437	0.724 19562	0.675 63306	0.829 39685	0.881 87922	4.823 83012	26.94 78958	14.15 16643	0.796 68599	16.98 53794	1.773 83247	22.63 96951	14.33 60077	0.801 99384	17.29 00568	1.383 25467	18.34 81841	14.48 48575	0.788 36610	18.43 87426	0.567 00267	0.395 18098			
1985	Chino ok_1	0.837 69496	0.732 29967	0.613 44375	0.179 14893	110.5 1	120.8 3	128.7 6	128.1 7	23.54 77201	21.42 46624	11.11 91182	177.4 03980	0.806 67194	13.56 63294	12.18 24488	10.83 42096	9.568 13793	96.17 35183	0.679 23798	11.44 61221	8.321 86947	19.91 99176	11.65 11828	220.4 63371	0.816 20322	13.90 50686	225.2 04895	0.752 67438	0.247 32561	0.780 97999	0.873 59443	0.918 23829	5.847 39862	21.27 92027	11.88 12015	0.815 29802	15.46 13027	2.244 86972	18.01 21782	12.12 83391	0.810 80667	15.79 02202	1.757 70418	14.50 20906	12.31 29358	0.801 22298	16.86 31515	0.675 00328	0.515 45130			
1986	Chino ok_1	0.806 22284	0.609 86474	0.491 68689	0.372 62137	119.1 6	122.7	128.4 3	142.6 3	21.12 38156	23.51 66154	12.85 80193	197.1 80571	0.843 18788	14.67 75893	10.63 54936	12.84 00648	11.18 05351	103.1 46002	0.748 84415	12.34 46580	7.722 23771	21.04 53752	13.35 52505	245.3 97875	0.843 83607	15.17 83607	0.472 20471	0.527 92547	0.693 45093	0.833 27377	0.883 97353	5.618 70277	22.16 69141	13.49 73291	0.827 61097	16.78 98834	2.159 10978	18.72 49256	13.82 74202	0.820 89181	15.05 90184	14.14 69512	0.816 28817	17.99 01552	0.556 96068	0.420 96494						
1987	Chino ok_1	0.750 06870	0.508 43497	0.381 36116	0.218 78394	118.3 6	126.7 7	131.9 7	127.4 2	19.99 58622	24.06 78451	13.87 93715	199.3 83029	0.856 50142	14.01 39197	9.940 16461	12.52 24085	12.67 40373	62.81 51608	0.830 54608	11.44 56408	7.215 36268	23.19 13713	14.45 74111	272.2 54804	0.806 39860	14.58 74724	280.7 29187	0.603 84488	0.396 15511	0.607 32974	0.804 40860	0.862 24939	5.223 95052	24.56 82714	14.50 18503	0.797 11859	16.64 17394	1.953 30478	20.61 44269	14.56 02331	0.797 24556	17.03 35454	1.526 09403	16.64 89424	14.63 15407	0.783 91104	17.99 91102	0.469 85156	0.287 66536			
1988	Chino ok_1	0.817 54518	0.720 14404	0.588 75029	0.065 57262	109.1 9	121.2 8	129.0 9	141.4 4	25.10 42929	20.46 71036	11.09 64251	138.2 48673	0.906 46929	13.36 02517	13.69 84417	8.805 70419	9.472 88398	57.70 76232	0.874 73048	11.28 21445	8.363 68376	19.37 00160	11.69 10220	180.3 37455	0.886 15305	13.82 39292	185.4 78179	0.900 58487	0.099 41512	0.772 39670	0.868 70813	0.913 16532	6.022 96621	20.46 93401	11.87 95358	0.882 15791	15.68 18546	2.334 56859	17.34 92054	12.11 30914	0.864 33665	16.14 48418	1.829 51203	13.95 10019	12.30 23905	0.861 91904	17.21 56343	0.654 17604	0.483 83071			
1989	Chino ok_1	0.796 47076	0.516 42293	0.411 31576	0.357 17082	143.3	151.4 4	155.7 8	145.7 8	17.68 36026	28.10 44613	14.06 66523	192.7 27534	0.875 65439	14.42 24506	8.814 45895	14.11 61829	12.41 19089	75.84 95163	0.846 51491	11.97 78778	6.562 36942	26.10 76104																														

Columbia River System Operations Environmental Impact Statement
Appendix E: Fish, Aquatic Macroinvertebrates, and Aquatic Habitat

Year	Species	InRivSurvSNK	InRivSurvLCol	InRivSurv	ProportionTransported	MedDayLGR	MedDayConfl	MedDayBONinriv	MedDayBONtrans	meanTravelTime	meanMigRate	meanTemp	meanFlow	meanFSpill	meanGas	SNKTravelTime	SNKMigRate	SNKTemp	SNKFlow	SNKFSpill	SNKGas	LCTravelTime	LCMigRate	LCTemp	LCFlow	LCFSpill	LCGas	BonFlow	propBONinriv	propBONtrans	JDAInRivSurv	DeschInRivSurv	BONinRivSurv	JDATime	JDAMigRate	JDATemp	JDAFSpill	JDAGas	DESTime	DESMigRate	DESTemp	DESFSpill	DESGas	BONTTime	BONMigRate	BONTemp	BONFSpill	BONGas	monte_q975	monte_q025			
1994	Chino ok_1	0.737 06186 1	0.454 00749 9	0.334 63161 2	0.350 19461 4	128.3 1	135.7 5	140.7 3	136.5 8	18.47 31787 8	26.16 06524 9	14.40 23344 9	157.0 26332 9	0.874 20729 2	13.47 16553 9	8.950 74897 3	13.57 82345 3	13.26 50827 4	63.86 97471 6	0.851 87552 3	11.72 77723 3	7.096 0906	23.37 85974 7	14.94 16842 5	207.2 87852	0.829 92096 7	13.64 43287 5	209.0 91079	0.409 27189 5	0.590 72810 5	0.562 01570 5	0.785 93512 7	0.846 84911 9	5.195 74360 5	24.63 66569 1	14.96 89172 8	0.825 69797 5	15.37 27914 8	1.958 15192 2	20.58 25344 4	15.01 19139 4	0.817 72877 8	15.62 75237 4	1.531 06276 7	16.59 70401 6	15.12 44220 7	0.810 03445 4	16.59 25684 1	0.420 85372 2	0.224 73977			
1995	Chino ok_1	0.814 29445 8	0.641 05570 3	0.522 00810 7	0.505 37019 8	122.5 8	124.8 7	131.4 3	141.4 5	21.40 42522 1	23.78 77583 4	12.69 56161 1	191.6 94329 4	0.818 11445 1	13.82 86235 7	11.11 85776 7	11.41 86509 5	10.93 03896	0.714 52901 4	10.98 63319 4	7.673 34339	21.49 91409 3	13.31 88810 9	236.4 96838 9	0.813 49338 1	14.33 76390 1	244.7 81295 8	0.354 11291 6	0.645 88708 4	0.705 28859 3	0.839 38912 2	0.889 74137 5	5.480 25676 6	22.83 75083 5	13.50 77497 5	0.808 35701 2	15.92 52273 6	2.084 10862 6	19.34 82215 6	13.78 04985	0.806 37526 5	16.24 76336 2	1.629 32804 2	15.61 48776 5	14.02 40216 3	0.801 97665 1	17.33 53958 1	0.585 78167 2	0.452 64098 7				
1996	Chino ok_1	0.783 24614 5	0.540 18499 1	0.423 03567 2	0.541 42567 5	137.9 1	136.8	140.1 8	152.2 4	16.07 05716 8	29.36 05642 8	14.46 52139 8	254.8 56857 8	0.816 97319 7	16.34 92992 3	7.310 15666 6	16.94 70295 9	13.43 14334 9	119.9 69429	0.733 27580 7	14.15 56846 6	6.487 34777 4	26.26 99430 5	14.78 73152 1	322.9 50302 1	0.795 20780 8	16.28 18188 3	330.5 01855 5	0.281 01855 5	0.718 98144 5	0.628 21613 8	0.810 49674 8	0.866 94558 9	4.632 53264 9	5.480 23751 4	28.02 23751 5	14.90 51342	0.776 86128 6	18.18 25281 1	1.703 15536 1	23.55 58262 8	2.084 15536 8	15.07 76999 1	0.805 11246 1	18.37 09936 1	18.37 09936 1	1.327 04889	19.12 17078	15.25 39663 3	0.801 96940 9	19.64 26048 3	10.983 10985 2	0.328 91854 2
1997	Chino ok_1	0.828 81934 3	0.573 76829 6	0.475 55026 2	0.562 85806	134	138.0 4	140.3 2	139.5 6	14.42 49741 5	31.10 42006 9	14.04 79245	356.0 36543 7	0.816 73319	20.99 19158	6.149 62913	20.57 85302	12.56 35406 5	165.3 27407 8	0.729 30477 9	18.22 02728	5.800 85980	29.58 94933	14.65 31025	461.3 33165	0.797 95721	21.52 77344	470.4 27459	0.283 82720	0.716 17279	0.663 25047	0.829 02974	0.881 70105	4.083 98353	31.72 45101	14.77 22797	0.769 40059	23.62 32742	1.450 79316	27.62 42013	14.94 09071	0.851 61356	23.15 07320	1.128 76441	22.50 18128	15.11 58199	0.854 43511	23.99 79763	0.550 1611	0.397 21702			
1998	Chino ok_1	0.834 60307	0.661 35496	0.551 96888	0.418 06908	114.9 7	122.1 8	128.8 8	130.3 1	21.29 94862	23.26 39743	12.47 54924	249.3 19958	0.843 99715	15.97 97246	10.92 97576	11.87 86842	10.34 21258	97.14 17770	0.800 3232	12.98 55524	7.448 89999	22.46 16452	13.28 53776	321.0 70739	0.802 39102	16.11 24312	338.6 76696	0.453 6063	0.546 3937	0.720 56170	0.842 00233	0.891 38436	5.314 59761	23.91 09472	13.50 99990	0.782 00987	18.03 59790	1.971 99843	20.39 59517	13.82 52642	0.815 71976	18.65 70288	1.539 02975	16.51 10381	14.06 74667	0.819 46945	20.01 29976	0.625 23207	0.459 72408			
1999	Chino ok_1	0.826 39859 9	0.642 41837	0.530 89364	0.388 71721	119.8 7	125.4 4	132.1 1	128.2 4	20.60 81864	23.55 75752	12.70 27992	206.3 45554	0.820 98685	12.84 66203	10.18 55237	12.84 16297	10.83 83245	97.01 82052	0.721 02414	11.80 48856	7.524 97088	22.16 82973	13.44 24106	266.5 80907	0.814 7841	14.83 33892	273.8 77136	0.472 31562	0.527 68438	0.704 17129	0.837 66735	0.888 12204	5.382 73488	23.57 01993	13.63 05028	0.805 51568	16.63 27680	2.024 50837	19.90 46824	13.86 52954	0.809 63331	16.95 92933	1.582 32691	16.06 75494	0.799 05828	18.02 56048	0.610 81209	0.435 08799				
2000	Chino ok_1	0.773 09515 3	0.464 92695	0.359 43277	0.472 03502	130.3 4	136.6 5	140.2 7	141.4 7	17.64 81965	26.91 44143	14.37 30664	189.6 71708	0.845 45089	13.99 50400	8.319 58277	14.89 35437	12.98 11555	84.77 81829	0.787 55261	11.79 86730	6.873 68169	24.35 13187	14.95 70438	244.4 07048	0.816 42498	14.36 77903	253.6 92276	0.305 40304	0.694 59695	0.568 85028	0.792 14382	0.852 85028	4.993 37998	25.76 74879	15.01 84171	0.806 87789	16.13 11080	1.862 06612	21.57 28025	15.10 67622	0.796 81696	16.38 81327	1.452 10024	17.48 61365	15.26 15919	0.780 82266	17.44 20576	0.458 67146	0.257 12247			
2001	Chino ok_1	0.800 69630 5	0.605 48224	0.484 80739	0.127 51816	110.6 7	122.9 8	130.5 9	127.1 1	25.34 69500	20.69 22008	12.44 68706	117.7 46146	0.878 53027	12.90 71510	13.99 22891	9.047 10022	10.11 10694	49.34 66178	0.829 77740	11.10 43262	8.383 93347	19.18 85324	13.46 90388	149.6 78655	0.858 42294	13.25 70195	160.7 00393	0.786 32374	0.213 67625	0.669 28904	0.813 95057	0.866 63690	6.073 52941	20.21 51549	13.67 44539	0.868 46936	14.69 17696	2.356 67952	17.17 15572	13.92 52901	0.863 02121	14.79 04478	1.845 15103	13.83 72765	14.10 12444	0.872 62123	15.77 87728	0.576 85373	0.375 42874			
2002	Chino ok_1	0.814 01675	0.651 66548	0.530 46662	0.253 78097	120.2	128.9 6	135.4 5	137.0 4	20.80 07140	24.12 06933	12.60 72429	179.4 59382	0.882 72669	14.10 88980	10.76 92314	11.44 29763	10.93 13037	68.16 04675	0.865 39833	11.95 08256	7.397 55073	22.45 85764	13.22 84797	235.2 47675	0.838 53056	14.37 89286	242.9 38079	0.628 75863	0.371 24136	0.711 56847	0.840 41496	0.890 12284	5.323 44690	23.81 89441	13.43 50145	0.826 17139	16.35 46796	2.004 50343	20.07 59441	13.68 44196	0.814 87015	16.60 70632	1.564 88431	16.24 40692	13.87 5916	0.805 22817	17.68 97411	0.609 73132	0.438 38963			
2003	Chino ok_1	0.804 77241	0.625 74714	0.503 58403	0.393 17388	130.9 4	137.2 2	144	140.9 4	18.95 99878	26.30 14076	13.19 94775	205.7 59560	0.858 24482	14.53 90144	9.592 00858	13.02 83541	11.72 63479	80.61 08444	0.809 47098	11.51 26913	6.918 18805	24.40 57024	13.82 54435	264.7 95430	0.828 01230	14.97 76500	289.7 67120	0.457 16698	0.542 83301	0.695 87792	0.838 86861	0.889 88326	4.942 44451	25.99 96045	13.96 49082	0.815 16500	16.87 44182	1.816 44509	22.04 48875	14.12 20731	0.818 41355	17.33 65395	1.412 55481	17.97 05333	14.26 08366	0.814 80631	18.48 49557	0.573 05788	0.419 32859			
2004	Chino ok_1	0.822 82622	0.666 59312	0.548 49029	0.102 44762	107.2 5	120.3 1	127.6 8	134.8 8	24.84 32214	20.75 22200	11.90 07249	168.0 42657	0.901 03655	13.98 06402	9.365 86374	9.532 37253	61.89 79934	0.887 45178	11.67 26291	8.129 64854	19.92 37049	0.862 03326	217.4 72297	12.81 33262	0.862 72297	14.37 60840	240.9 52590	0.838 85467	0.161 14532	0.722 48294	0.840 44655	0.889 30460	5.897 63102	20.99 86390	13.04 46474	0.849 21864	16.27 54144	2.257 97934	17.85 52484	13.39 93600	0.821 51236	16.77 24275	1.763 27551	14.45 74171	13.66 7099	0.809 04749	17.86 69443	0.630 20392	0.434 51360			
2005	Chino ok_1	0.781 91540	0.559 48171	0.437 46736	0.388 87090	121.6 8	127.9 2	133.8 8	134.6 9	20.46 31853	24.11 22200	13.75 0222	172.3 78718	0.856 69742	13.75 28435	10.33 89963	12.10 82418	12.27 45393	70.94 25674	0.801 28670	11.40 43422	7.475 10957	22.02 26653	14.30 96777	220.8 83692	0.831 22199	14.16 51950	231.4 83764	0.429 04741	0.570 95258	0.637 95529	0.807 06565	0.862 84691	5.424 73030	23.25 96185	14.45 31568	0.826 28549	15.81 37985	2.049 87493	19.64 39320	14.64 33639	0.815 06069	16.11 33953	1.600 86041	15.88 62702	14.79 64634	0.810 48822	17.07 93352	0.533 82900	0.332 92521			
2006	Chino ok_1	0.843 65429	0.715 11996	0.603 31403	0.556 22135	120.5 5	126.0 7	132.8 5	128.4 1	19.09 36960	24.77 22587	11.77 07249	241.2 06547	0.802 73387	15.69 76229	8.887 65754	15.03 10665	10.51 16861	127.4 89770	0.682 27024	13.58 46563	7.309 21542	23.17 35101	12.28 95174	303.2 25463	0.804 48735	15.99 77873	317.0 92529	0.340 18377	0.659 91087	0.769 38124	0.871 28955	0.917 28955	5.157 69064	24.78 95436	12.47 11771	0.788 15449	17.52 71202	1.913 58089	21.00 08477	12.62 24765	0.800 31800	17.66 63155	1.492 62744	17.01 58644	12.70 74383	0.794 98887	18.63 98887	0.684 04537	0.507 70785			
2007	Chino ok_1	0.787 03704	0.569 88996	0.448 52451	0.355 48152	120.2 1	127.6 2	132.8 9	129.2 9	20.63 64043	23.63 68912	13.52 92947	189.0 12692	0.850 73187	13.72 72260	10.44 89734	12.04 92464	12.09 11373	71.15 09719	0.808 12722	11.10 63444	7.357 20110	22.49 83444	14.15 72432	250.6 38638	0.811 60188	14.23 08739	259.0 12054	0.469 99142	0.530 00857	0.646 66613</																						

Columbia River System Operations Environmental Impact Statement
Appendix E: Fish, Aquatic Macroinvertebrates, and Aquatic Habitat

Year	Species	InRivSurvSNK	InRivSurvLCol	InRivSurv	ProportionTransported	MedDayLGR	MedDayConfl	MedDayBONinriv	MedDayBONtrans	meanTravelTime	meanMigRate	meanTemp	meanFlow	meanFSpill	meanGas	SNKTravelTime	SNKMigRate	SNKTemp	SNKFlow	SNKFSpill	SNKGas	LCTravelTime	LCMigRate	LCTemp	LCFlow	LCFSpill	LCGas	BonFlow	propBONinriv	propBONtrans	JDAInRivSurv	DeschInRivSurv	BONInRivSurv	JDATime	JDAMigRate	JDATemp	JDAFSpill	JDAGas	DESTime	DESMigRate	DESTemp	DEFSpill	DESGas	BONTTime	BONMigRate	BONTemp	BONFSpill	BONGas	monte_q975	monte_q025
1931	Chino ok_1	0.778 36170 5	0.610 27682 2	0.475 01610 8	0.121 55208 1	105.3 4	119.8 9	127.6	133.3 1	27.32 92986 5	19.51 76205 8	12.21 74782 1	121.6 81126 2	0.765 46290 1	10.59 61746 5	15.13 85639 6	7.794 68998 5	10.04 58320 6	44.14 29138 2	0.730 27991 1	9.465 76480 9	9.094 73943 7	18.36 38439	13.02 62797 7	157.7 12684 6	0.677 51400 7	9.655 51734	170.3 04031 4	0.791 68525 3	0.208 31474 7	0.695 95358 7	0.832 67786 1	0.885 08155 2	6.168 73908	19.81 69478 8	13.22 70582 2	0.716 55389 7	10.65 67844 4	2.404 40058 7	16.84 76628 9	13.55 66848 1	0.706 64599 5	11.56 09429 7	1.883 55475 7	13.56 46712 3	13.82 34658 2	0.728 79619 9	12.92 19398 5	0.554 47686 8	0.387 86324 6
1932	Chino ok_1	0.829 31829 6	0.715 23066 2	0.593 15387 4	0.418 11799 7	117.2 3	125.2 2	132.5 7	128.7 6	22.11 05061 5	23.08 16645 7	11.62 71099 4	230.2 83583 5	0.722 01735 3	12.67 40660 3	11.34 93927 9	11.56 42285 8	10.11 97042 5	91.78 30108 6	0.601 16968 8	9.768 55201 7	7.824 70013 9	22.41 47692 1	12.17 90440 9	126.8 56769 8	0.683 73369 2	12.33 31919 5	321.3 57513 4	0.470 19293 4	0.529 80706 6	0.776 47441 4	0.872 89249 1	0.918 67733	5.253 96444 6	24.37 13100 8	12.38 14485 5	0.697 38022 1	13.74 09936 9	1.944 08940 5	20.66 39266 9	12.62 69098 9	0.754 12352 9	14.28 77969 7	1.515 76637 5	16.76 02557 9	12.79 97088 4	0.756 66958 1	16.49 77455 1	0.665 72365 9	0.496 78324 4
1933	Chino ok_1	0.784 15533	0.613 72318 2	0.481 25430 4	0.457 10211 4	132.6	141.0 9	147.8 3	139.4 3	20.14 67088 5	25.99 84117 9	13.28 78775 6	185.4 97985 3	0.755 69520 3	11.57 47973 9	10.50 30849	11.38 64073 1	26.139 26139 5	60.61 4711	0.700 86749 2	9.435 63633	7.222 75420 3	24.75 51867 2	13.91 41974 4	251.5 51867 4	0.679 23293	10.99 19498	278.6 76086 4	0.382 321.3 3	0.617 76913 7	0.698 85005	0.841 29961 7	0.892 9139	4.815 22833 6	27.01 14652 4	14.07 28918 1	0.715 79847 3	12.31 76027 3	1.754 31563	22.82 52446 5	14.26 96857 5	0.747 32128 8	13.58 58093 9	1.364 39134 9	18.60 03440 2	18.41 88127 5	0.734 03638 6	15.58 43353 3	0.578 56527 4	0.370 68933 9
1934	Chino ok_1	0.787 96029 1	0.597 47685	0.470 78803 3	0.212 16184 2	113.8	122.0 7	128.3 2	131.6	21.68 48707	22.75 43560 2	12.98 10417	227.6 41074 6	0.769 48175	13.21 57802 2	10.98 24767	11.83 93100 5	11.47 53633 5	79.37 52029 5	0.719 74699	11.58 55499	7.698 28926 8	21.91 84433 8	13.52 60510 4	310.1 11038 2	0.695 66886 1	12.25 10124	316.1 73767 1	0.653 10902 8	0.346 89097 2	0.685 28044	0.836 29151 8	0.889 14310 9	5.398 70440	23.47 78222 6	13.65 52326 2	0.691 63759 4	13.55 40885 9	2.041 66271 5	19.74 36195 3	13.84 78711 4	0.754 42286 8	13.91 30833 9	1.596 06366 6	15.93 17151 7	14.02 28104 6	0.756 06134 5	16.24 93643 8	0.551 94756 8	0.388 17826 8
1935	Chino ok_1	0.781 16337 6	0.597 24703 3	0.466 54750 8	0.502 21610 5	126.4	134.5 9	141.9 5	133.9 2	20.21 41746	25.03 29112	13.36 63209	176.4 54708	0.745 5908	11.21 21855 2	10.19 89621 9	11.63 89125 9	11.94 25876 6	63.68 86184	0.679 22835	9.268 69792	7.469 33645	23.58 10527 1	13.96 34216	235.4 21958	0.673 68874	10.57 10295	250.4 72381 6	0.333 41111	0.666 58889	0.685 83464	0.839 3088	0.891 93940	5.036 36211	25.62 77981	14.10 28541	0.713 19394	11.82 68310	1.859 83441	21.58 06971	14.25 25962	0.735 81009	13.13 49360	1.449 26942	17.51 96819	14.38 87591	0.710 66208	15.15 39845	0.563 93861	0.359 06078
1936	Chino ok_1	0.843 41758 4	0.717 67294 3	0.605 29798	0.405 40344 6	115.5 5	122.4	130.1	129.2 8	20.68 45263	23.77 53316	11.33 67248	241.8 98779	0.696 01214	13.94 18645	9.873 48341	13.43 63807	9.890 33126	123.3 25486	0.528 44711	12.88 44364	7.918 29352	22.14 90725	11.82 61238	301.3 69074	0.683 65597	12.57 12457	314.6 48559	0.489 03690	0.510 96309	0.782 38503	0.879 75841	0.925 2584	5.312 30597	24.08 66495	12.03 29549	0.688 89007	13.58 64568	1.976 37625	20.34 28022	12.26 72313	0.748 85364	14.11 75635	1.541 86447	16.48 13272	12.46 04010	0.752 84537	16.48 10948	0.653 60666	0.520 21746
1937	Chino ok_1	0.790 00604 5	0.625 29487 8	0.493 98673 3	0.448 01659 8	123.0 1	130.8 6	137.3 9	131.9 6	23.57 99940	22.27 40914	12.46 89198	140.2 01056	0.729 97678	10.61 30125	12.51 37635	9.535 81676	10.88 36442	58.15 94207	0.664 65094	9.227 52914	8.336 51293	20.58 43256	13.13 84004	180.9 65815	0.649 40453	9.726 57259	193.9 70108	0.396 99581	0.603 00418	0.706 09808	0.840 85973	0.892 89419	5.605 88659	22.32 27108	13.31 49248	0.687 23687	10.69 75433	2.135 06843	18.88 89735	13.50 28079	0.691 90862	11.60 59360	1.668 92020	15.25 29643	13.63 33556	0.713 54760	12.97 11189	0.588 24782	0.382 16673
1938	Chino ok_1	0.816 02014 3	0.631 79692	0.515 55901	0.614 11365	127.1 1	131.5 4	135.4 2	139.1 2	18.39 32473	26.23 67862	12.92 18940	235.6 53475	0.730 76115	13.58 62788	8.572 36494	14.87 16955	11.45 71565	114.9 40339	0.604 48120	12.06 75272	7.260 86211	23.84 53387	13.40 15714	303.2 57665	0.701 37532	12.78 95063	310.7 80548	0.256 91666	0.743 08333	0.709 83903	0.847 05346	0.897 71099	4.994 55785	25.74 86218	13.56 82607	0.706 22689	14.02 46236	1.856 29555	21.65 86218	13.80 33997	0.753 80775	14.49 72159	1.448 77746	17.52 55295	14.02 16245	0.744 78258	16.60 12778	0.593 02031	0.420 12172
1939	Chino ok_1	0.816 30217 3	0.707 72170 1	0.577 71476	0.484 89467	113.6 1	121.8 7	129.8 7	127.9 2	22.27 28155	22.53 18977	11.28 40258	193.5 57336	0.703 05698	11.67 88528	10.94 227	11.91 97461	10.41 54808	92.57 55386	0.567 93134	9.663 19541	8.389 40534	20.87 03232	11.55 83594	247.7 36877	0.667 19050	11.25 8075	254.1 72882	0.398 07421	0.601 92579	0.782 18406	0.884 03570	0.929 84481	5.553 07611	22.75 45479	11.68 01963	0.695 55467	12.28 36250	2.103 70162	19.17 66169	11.81 32054	0.723 97530	13.19 55941	1.645 18645	15.46 66739	11.90 13462	0.699 37580	15.23 22864	0.637 83316	0.482 20407
1940	Chino ok_1	0.802 18808 4	0.708 96172 1	0.568 72064 4	0.101 01874	94.9	111.4 3	120.6 4	134.7 8	29.75 70499	18.31 10553	11.10 62672	166.4 51396	0.655 41060	10.31 54540	16.55 69473	8.498 57593	9.468 54400	79.27 41790	0.443 48196	7.488 46950	9.618 43938	17.75 50797	11.50 88543	208.8 39098	0.659 72273	10.19 73142	219.4 30892	0.846 50746	0.153 49253	0.778 17788	0.872 83751	0.918 97508	6.285 76583	19.35 72879	11.73 25368	0.701 93248	11.24 02526	2.465 15227	16.45 89582	12.10 48812	0.703 90418	12.43 33245	1.933 15345	13.22 70396	12.41 35956	0.700 41038	14.14 92490	0.628 07734	0.468 85053
1941	Chino ok_1	0.734 63172 8	0.489 42696	0.359 54857	0.456 76835	128.8 9	131.8	135.6 6	145.5 5	20.63 76286	24.45 28104	14.32 68767	145.0 39333	0.735 33982	10.69 77649	10.23 69107	11.40 98837	13.09 31909	57.07 11288	0.690 68283	9.430 35697	7.963 73388	21.31 67080	14.72 72841	189.5 16764	0.640 22395	9.661 21872	0.320 17531	0.679 82468	0.603 99511	0.794 79881	0.854 98064	5.471 06358	22.97 45145	14.81 83979	0.677 61897	10.73 10585	2.085 44284	19.34 01787	15.02 32887	0.684 62988	11.62 5844	1.630 64691	15.60 32658	15.22 61366	0.711 09442	12.93 89886	0.444 32883	0.259 36009	
1942	Chino ok_1	0.796 31621 6	0.661 69253	0.526 91649	0.622 94916	133.5 2	134.9 4	140.7 6	145.5 6	21.35 36022	25.00 63725	12.53 36754	185.0 32775	0.700 23581	11.26 84932	11.09 44649	11.22 24658	11.19 54134	81.57 68569	0.574 54783	9.010 54039	7.866 24849	22.27 73679	12.95 91784	235.1 30231	0.655 09495	10.58 46859	243.7 24166	0.254 86806	0.745 13193	0.736 99489	0.860 10616	0.909 72883	5.215 37817	24.28 28009	13.14 58807	0.681 51540	11.67 10470	1.966 43868	20.47 85020	13.36 09399	0.709 40917	12.60 18298	1.536 33336	16.54 11093	13.54 99539	0.726 7057	14.36 47246	0.596 92263	0.453 10944
1943	Chino ok_1	0.833 52804 8	0.685 45025	0.571 34201	0.463 11517	120.1 5	122.5 8	128.5 2	131.1 8	22.22 20541	22.90 06787	11.74 19366	226.2 29721	0.724 28288	13.86 34545	11.18 42770	12.71 67926	10.23 00985	121.1 61999	0.589 19496	13.47 68703	8.088 73494	21.12 95793	12.22 51537	288.0 04053	0.699 00034	12.50 92446	300.9 77783	0.413 21069	0.586 78930	0.751 83097	0.863 05006	0.910 60132	5.515 07766	22.83 19502	12.42 67862	0.710 15806	13.49 88901	2.089 01913	19.30 17503	12.68 09107	0.757 75210	14.10 74555	1.633 11283	15.57 82765	12.89 55431	0.750 91061	16.27 59428	0.646 41753	0.484 70229
1944	Chino ok_1	0.782 62239 9	0.574 02630 4	0.449 24584	0.567 00387	130.6 1	138.2 9	145.2 4	138.1	20.74 68599	24.49 27926	13.32 31520	135.5 11025	0.727 43886	10.49 96045	10.36 84102	11.17 46789	11.81 18740	65.20 77774	0.648 56033	9.161 43169	7.938 17743	21.63 00545	13.96 20273	170.6 01285	0.656 																								

Columbia River System Operations Environmental Impact Statement
Appendix E: Fish, Aquatic Macroinvertebrates, and Aquatic Habitat

Year	Species	InRivSurvSNK	InRivSurvLCol	InRivSurv	ProportionTransported	MedDayLGR	MedDayConfl	MedDayBONinriv	MedDayBONtrans	meanTravelTime	meanMigRate	meanTemp	meanFlow	meanFSpill	meanGas	SNKTravelTime	SNKMigRate	SNKTemp	SNKFlow	SNKFSpill	SNKGas	LCTravelTime	LCMigRate	LCTemp	LCFlow	LCFSpill	LCGas	BonFlow	propBONinriv	propBONtrans	JDAInRivSurv	DeschInRivSurv	BONInRivSurv	JDATime	JDAMigRate	JDATemp	JDAFSpill	JDAGas	DESTime	DESMigRate	DESTemp	DESFSpill	DESGas	BONTTime	BONMigRate	BONTemp	BONFSpill	BONGas	monte_q975	monte_q025
1949	Chino ok_1	0.796 21076 6	0.568 73839 1	0.452 83563	0.688 31622 1	126.0 5	130.7 1	136.3 9	132.2 6	16.94 18489 9	27.43 92374 3	13.69 71555 4	271.5 94163 6	0.736 21250 7	15.38 04482 1	7.571 23708 7	16.67 66189 6	12.23 64370 3	126.4 43009 9	0.585 95325 4	12.89 40111 2	6.705 90823 9	26.11 47903 4	14.34 46523 3	349.1 21048	0.729 53499 4	15.25 62082 6	383.5 56671 1	0.180 60374 8	0.819 39625 2	0.668 15082 9	0.831 67783 2	0.885 06917 2	4.639 50771 1	28.19 47275 3	14.44 72763 1	0.735 66391 5	16.72 61392 6	1.655 87762	24.15 02135 5	14.58 31518 2	0.788 55315 8	17.16 53747 6	1.286 302	19.72 68023 7	14.70 45960 4	0.794 95748 9	18.57 44085 3	0.535 40791 5	0.357 82025 5
1950	Chino ok_1	0.803 42944 5	0.670 58555	0.538 76817 7	0.660 50830 7	130.2 4	134.4 5	140.4 8	139.1 2	19.94 33511 6	25.71 6729	12.53 42969 9	211.4 01341	0.726 16803 9	12.18 00767	10.04 65631	12.41 77853 8	11.27 07229 6	91.57 49267 6	0.601 92808 5	9.857 88230 9	7.425 35937 6	23.77 99041 1	13.01 18947	270.7 91697 2	0.692 78568	11.62 54402	286.6 20361 3	0.228 46290 2	0.771 49070 7	0.742 32218	0.862 80709 7	0.910 49368 1	25.89 02249 2	13.19 11903 4	0.714 39831 3	12.87 99272 5	1.836 15765 7	21.85 67446	13.36 77984 9	0.755 40292 3	13.80 24266 6	1.430 77699 1	17.74 38223 7	13.48 98128 5	0.9547 09547 4	16.10 16559 6	0.623 63814 9	0.442 77450 7	
1951	Chino ok_1	0.820 72674 8	0.633 50739 7	0.519 93646 6	0.596 94527 7	130.8 9	131.7 6	137.2 7	138.0 7	18.54 57962 7	26.48 52794 4	13.08 28793 4	260.7 30697 1	0.754 97478 7	14.52 92697 3	9.017 58506 1	14.21 69607 4	11.45 75639 7	108.7 15062	0.643 60126 3	12.00 96223 8	6.984 25188 7	24.80 51485 3	13.70 12812 3	337.3 09855 1	13.88 49885 5	348.9 27154 5	0.272 92484	0.706 07516	0.706 41848	0.894 29218 3	0.894 04229 5	4.814 43610 8	26.77 29563 9	13.88 55865 5	0.725 40473 9	15.38 29723 4	1.771 66092 4	22.66 16528	14.11 72014 9	0.777 17715 5	16.03 15698	1.381 24713 3	18.37 45626 7	14.30 84592 8	0.776 51566 3	18.31 36158 6	0.596 20000 3	0.418 88531 3	
1952	Chino ok_1	0.848 13822 4	0.733 86457 4	0.622 41859 9	0.653 55887 9	122.1 1	121.7 1	129.1 7	133.3	18.82 53914 2	25.51 51910 9	11.50 60610 4	288.0 63582 3	0.720 69970 6	16.55 84310 8	8.488 74360 5	16.23 77748	10.22 07925 1	163.3 07925 4	0.546 87981 6	16.17 75756 6	7.560 61009 3	22.95 01722	11.84 04512 3	352.7 90466 8	0.725 89966	14.97 26444 9	362.1 00891 1	0.259 38483	0.740 61516 4	0.788 78123	0.880 73935 6	0.925 41851	5.152 66326 8	24.84 29959	12.06 19882 6	0.716 39788	15.88 68772 2	1.910 65651	21.04 60040 9	12.31 52637 5	0.778 37814 9	16.33 15528 2	1.491 18987	17.03 28086	12.53 07464	0.788 54864	18.50 82640	0.682 10806	0.546 20632
1953	Chino ok_1	0.808 44449 9	0.654 70637	0.529 29376	0.518 17149	128.1 5	128.3 7	135.6 6	142.4 9	21.16 68577 1	24.66 16831 2	12.61 68282 4	206.9 18664 7	0.734 80202 9	12.43 78929 5	10.99 56862 3	11.19 40662 5	10.99 63544 8	84.52 59567	0.625 40861 4	10.16 41813	7.660 83412 6	22.73 19458	13.23 22615	264.1 4608	0.693 36657	11.88 81886	278.7 58667	0.344 09887	0.655 90112	0.729 59758	0.854 30395	0.903 63808	5.142 08417	24.69 97781	13.41 24355	0.719 18691	13.20 04863	1.919 93980	20.94 41210	13.65 57757	0.745 81434	14.23 03937	1.498 34840	16.95 32443	13.85 78224	0.734 43925	16.17 90113	0.592 15327	0.456 58385
1954	Chino ok_1	0.812 63644	0.656 69777	0.533 65654	0.504 74201	140.4 3	147.5	147.6 5	144.0 8	19.16 06807	26.89 84285	12.78 16974	230.6 86217	0.760 50429	13.54 41213	9.791 73326	12.65 51512	11.43 47589	90.82 91188	0.678 91188	11.25 70333	6.989 71455	25.34 69160	13.32 77155	296.8 13990	0.708 75055	12.70 57567	303.6 41326	0.359 08223	0.640 91776	0.729 91615	0.856 97487	0.906 33694	4.682 00223	27.60 19363	13.49 46403	0.716 91684	13.86 07807	1.728 89059	23.21 06025	13.65 23977	0.761 32559	14.78 41984	1.347 35956	18.83 43727	13.76 60727	0.754 60073	17.27 86583	0.604 73210	0.449 22535
1955	Chino ok_1	0.797 13859 6	0.647 69581 4	0.516 30333	0.712 72762	133.4 8	133.9 2	140.6	142.8 2	20.19 50129	25.37 72896	12.78 62689	186.9 38162	0.703 41945	11.49 96495	10.15 05804	11.79 53982	11.32 32696	84.65 58380	0.579 36528	9.422 03121	7.629 08178	22.90 95953	13.30 00432	234.7 18162	0.658 50797	10.85 45885	245.4 81109	0.182 30641	0.817 69359	0.724 63702	0.852 63702	0.902 94515	5.114 50630	24.90 86768	13.48 42895	0.683 13152	11.91 96121	1.911 29872	21.03 26473	13.72 37757	0.708 83546	12.73 83546	1.491 24401	17.03 31235	13.93 38202	0.722 66396	14.44 33612	0.596 01397	0.423 14908
1956	Chino ok_1	0.853 65496 5	0.734 79606	0.627 26231	0.400 16435	114.8 9	119.7 9	127.4 1	133.4 7	20.10 36021	24.36 15819	11.31 67096	292.0 43204	0.759 69080	16.91 03168	9.562 92112	14.74 82987	9.884 14955	146.8 02978	0.624 11964	15.14 68910	7.654 22345	22.37 72199	11.71 41812	374.4 28649	0.752 51280	16.61 19376	375.7 52868	0.499 67364	0.500 32635	0.790 23670	0.881 96516	5.237 72407	24.16 49992	11.94 20345	0.740 03800	17.87 37731	1.955 30042	20.59 36895	12.21 18832	0.785 48276	17.77 77299	1.527 66928	16.63 18673	12.44 89760	0.788 92386	19.54 50010	0.674 07949	0.562 50377	
1957	Chino ok_1	0.823 95942	0.716 99054	0.590 77111	0.432 45821	113.2 7	120.4 3	128.3 6	138.0 2	22.39 10867	23.46 45973	11.66 40727	273.0 71515	0.721 38001	14.90 81112	11.62 07391	11.64 65961	10.32 40289	115.3 37225	0.555 65363	11.19 53468	7.988 95240	22.03 95126	12.00 25412	335.0 46895	0.720 17617	14.54 52231	359.0 91796	0.455 01791	0.544 98208	0.784 47813	0.879 81245	0.924 51041	5.246 55557	24.07 91437	12.19 09360	0.744 00557	16.03 99276	1.939 32006	20.69 97452	12.47 65688	0.778 86917	17.37 28262	1.511 05210	16.81 21529	12.74 63049	0.779 00543	19.35 90951	0.632 48620	0.537 26601
1958	Chino ok_1	0.820 52310 9	0.644 39675 6	0.528 74243	0.632 27954	124.6 6	130.4 2	136.6 4	135.8 3	17.45 32091	27.71 01819	12.78 90623	271.9 23308	0.755 34117	15.30 29781	8.255 50032	15.20 50524	11.43 14336	119.5 09194	0.653 94295	13.23 14111	6.652 66087	26.85 63511	13.41 61117	349.8 18023	0.717 51036	14.51 26011	370.4 02465	0.248 13348	0.751 86651	0.723 94285	0.855 03000	0.904 69620	4.514 95364	29.18 94410	13.56 08209	0.723 36094	15.85 08436	1.618 20617	24.74 54806	13.67 98760	0.781 86255	16.49 89045	1.258 61677	20.16 15196	13.74 07302	0.789 83426	18.55 05237	0.597 09819	0.447 46662
1959	Chino ok_1	0.793 06384 1	0.582 47492	0.461 93980	0.607 74568	134	137.1 7	141.1 8	142.8 8	18.95 27508	26.81 60553	13.52 49558	227.2 04332	0.748 87544	12.67 78935	9.586 43797	12.92 92732	11.91 39099	84.00 53283	0.655 46182	9.769 15397	6.979 36536	25.00 16422	14.23 77829	304.3 62711	0.701 15805	12.56 24810	316.9 47570	0.241 99285	0.758 00714	0.669 10749	0.829 12524	0.883 2763	4.771 29270	27.06 06091	14.38 10314	0.711 19680	14.16 02884	1.761 97446	22.78 76783	14.54 66973	0.757 59561	14.70 74861	1.373 79191	18.47 38305	14.67 06624	0.752 38043	16.66 54791	0.549 24517	0.361 53168
1960	Chino ok_1	0.794 61318 5	0.642 46602	0.510 51197	0.641 99269	132.0 1	136.0 1	140.5 8	139.8 2	20.56 08546	25.60 48144	12.83 21667	203.7 83138	0.718 97271	11.73 11854	10.70 56485	11.65 46818	11.31 69862	80.87 33078	0.596 97617	9.164 92881	7.405 50570	23.92 83586	13.36 16167	266.8 85968	0.680 12399	11.30 81835	282.8 18939	0.233 09068	0.766 90931	0.722 56292	0.854 96709	0.904 76322	4.939 37712	26.08 04531	13.52 87820	0.708 20950	12.69 35344	1.825 78837	21.98 43132	13.73 89589	0.745 24944	13.72 04411	1.422 94051	17.84 06068	13.93 22028	0.729 31654	15.85 85033	0.591 54670	0.410 75877
1961	Chino ok_1	0.796 07833	0.618 24267	0.492 16959	0.324 85786	117.6 5	126.0 6	133.5 7	131.7	22.85 18518	22.93 93902	12.78 09220	191.4 80184	0.751 84107	11.88 05784	12.15 66884	10.11 20920	10.94 77129	63.95 42961	0.690 79862	9.608 88977	7.931 33246	21.93 84826	13.55 97092	255.2 35979	0.678 63190	11.28 58220	264.3 28613	0.525 70741	0.474 29258	0.701 25272	0.841 59833	0.893 19297	5.324 71191	23.83 45468	13.73 24380	0.713 90214	12.70 78905	1.994 85411	20.19 04898	13.93 55236	0.738 59025	14.03 26557	1.558 64774	16.30 73740	14.09 29269	0.717 96415	15.99 78876	0.565 93491	0.417 63498
1962	Chino ok_1	0.821 52816 9	0.671 54977	0.551 69706	0.476 15793	118.7 3	126.3 3	133.6 7	129.3 3	21.65 25268	23.24 19295	12.09 70239	192.0 62597	0.707 67411	11.54 33707	10.78 75523	11.62 57984	10.46 68539	87.43 89923	0.581 41861	9.422 90706	8.040 98758	21.87 73649	12.73 96696	248.8 14626	0.666 72458	11.14 37741	253.0 95947	0.396 14231	0.603 85768	0.743																			

Columbia River System Operations Environmental Impact Statement
Appendix E: Fish, Aquatic Macroinvertebrates, and Aquatic Habitat

Year	Species	InRivSurvSNK	InRivSurvLCol	InRivSurv	ProportionTransported	MedDayLGR	MedDayConfl	MedDayBONinriv	MedDayBONtrans	meanTravelTime	meanMigRate	meanTemp	meanFlow	meanFSpill	meanGas	SNKTravelTime	SNKMigRate	SNKTemp	SNKFlow	SNKFSpill	SNKGas	LCTravelTime	LCMigRate	LCTemp	LCFlow	LCFSpill	LCGas	BonFlow	propBONinriv	propBONtrans	JDAInRivSurv	DeschInRivSurv	BONInRivSurv	JDATime	JDAMigRate	JDATemp	JDAFSpill	JDAGas	DESTime	DESMigRate	DESTemp	DESFSpill	DESGas	BONTTime	BONMigRate	BONTemp	BONFSpill	BONGas	monte_q975	monte_q025
1967	Chino ok_1	0.803 69135 3	0.709 51803 7	0.570 23351 2	0.461 54107 2	124.5 8	132.2 4	139.4 7	135.9	21.68 21905 2	24.47 38646 6	11.89 69792 6	194.8 76444 1	0.764 81634 2	12.08 38058 7	11.54 16162 6	10.16 17274 6	10.77 39423 8	63.86 32141 1	0.711 24223 5	9.921 61674 5	7.606 42180 6	23.39 64514 9	12.30 26862 1	259.5 44273 4	0.691 86993 9	11.43 09469 1	276.8 96118 2	0.418 80428 7	0.581 19571 3	0.776 78124 4	0.878 72456 1	0.924 44007 8	5.029 44956	25.55 54430 1	12.46 41365 1	0.722 98036 2	12.80 85807 8	1.851 90082 3	21.68 25243 4	12.62 27919 9	0.752 65505 3	14.02 93690 6	1.443 69448	17.58 66105 1	12.74 41506 4	0.742 73182 5	15.95 17264 4	0.633 28165 9	0.484 90965 2
1968	Chino ok_1	0.714 26877 9	0.447 33938 4	0.562 52055 5	0.562 69303 1	137.9 1	140.3 3	142.1 9	147.9 5	18.47 74831 8	26.78 94570 7	15.05 56761 2	173.3 93584 7	0.755 77354 9	11.53 10955	8.947 55993	13.16 61711 1	14.10 03147 1	68.98 48526	0.680 93569 3	9.684 47265 6	7.270 06887 6	23.26 55372 4	15.32 98675 2	221.6 14214 6	0.696 02552 1	10.80 88269 2	229.3 37951 7	0.215 48034 4	0.784 51965 6	0.570 17789 1	0.786 23251 3	0.847 78730 5	5.072 23700 7	24.96 35778 8	15.37 6828	0.721 87056 5	11.98 45476 2	1.914 16042 3	20.99 69446 4	15.55 48909 5	0.737 90186 6	12.77 44229 6	1.493 16840 6	17.01 18881 5	15.76 98302 3	0.736 81378 4	14.62 66384 1	0.408 74871 3	0.221 17603 3
1969	Chino ok_1	0.835 76627 7	0.648 42030 6	0.541 92782 6	0.413 70252 6	115.4	121.9 7	129.4	131.3 5	21.24 79487 1	23.32 00138 9	12.41 42832 8	247.5 20314 4	0.724 32952 7	14.13 57853 4	10.44 13279	12.64 82219 7	10.29 73268 5	112.6 47865 3	0.593 86594 3	12.35 60602 2	7.895 74245 4	21.87 54204	13.22 59217 9	311.9 57183 8	0.695 21438 1	13.18 90714 2	321.6 02691 5	0.450 65922 5	0.549 34077 5	0.718 61328 9	0.844 66698 4	0.894 87336 9	5.372 78298 3	23.67 62498 9	13.46 89569 5	0.705 10495 9	14.58 64280 7	2.001 14057 2	20.11 57659 9	13.77 75414 8	0.757 27804 5	15.14 64220 7	1.562 75159 9	16.26 48821 9	17.01 29473 3	0.753 08048 7	17.33 22887 4	0.614 85178 6	0.456 85558 8
1970	Chino ok_1	0.800 9602	0.685 55902	0.549 10549	0.555 13436 9	121.2 7	127.0 5	134.8	141.2 5	22.46 76445 4	23.52 35283 5	12.10 23196 5	177.0 80823 1	0.755 67511 8	12.11 60060	11.79 51430 4	9.679 73530 5	10.66 11711 5	76.17 97409 3	0.663 10676 6	10.40 67777 6	8.173 54749 9	21.22 90562 4	12.58 14286 9	216.3 20643 1	0.710 65319 1	11.22 32585	222.3 83453 4	0.321 27848 3	0.678 72151 5	0.757 53827 5	0.868 13597 3	0.915 30836 4	5.450 19816 6	23.09 00320 5	12.77 57482 5	0.747 24212 3	12.32 14353 6	2.056 97336	19.59 10807 8	13.01 48112	0.754 98611 7	13.66 15419 4	1.607 41572 8	15.82 33990 9	13.21 15974 4	0.736 70773 2	15.75 52061 1	0.604 05697 2	0.473 90648 7
1971	Chino ok_1	0.826 88289 7	0.602 00199 6	0.497 78515 4	0.725 65532 4	139.1 6	145.5 8	147.3 2	142.8 2	14.49 42852 7	31.93 40437 3	13.64 00628 4	329.4 00628 2	0.787 43010 5	19.06 86885 3	6.418 53170 1	19.81 89896	12.42 76487 4	155.1 73272 7	0.653 30718 2	16.40 45394 9	5.722 51423 4	30.83 38549	14.27 04261 1	424.5 40486 7	0.792 91460 9	19.24 16722	429.2 67211 9	0.167 12364 2	0.832 87635 8	0.683 51396 8	0.839 10884	0.891 15587	3.952 95067 9	33.33 03762 9	14.37 61041 6	0.779 96814 3	20.97 00130	1.398 52225	28.66 94339	14.43 94912	0.819 33279	21.14 84438	1.088 23575	23.35 31182	14.46 59438	0.824 22176	22.26 75228	0.585 16520	0.404 68736
1972	Chino ok_1	0.826 88314 6	0.616 25035 7	0.509 56703 4	0.537 16472	120.8 6	126.7 9	133.5 6	136.9 9	18.52 13860 5	26.23 41482 9	13.18 73946 2	277.6 36192 9	0.759 64944 7	15.63 15299	8.960 07060	13.81 18374 7	11.31 58653 3	114.5 35069	0.654 68521 1	12.58 35241 3	6.978 0958	24.93 66344	13.98 04013 6	356.4 95707 2	0.726 94453	15.51 75999	359.4 31213	0.319 69219	0.680 30780	0.694 16171	0.837 43192	0.889 09628	4.957 15282	26.99 96448	14.16 00933	0.733 69606	17.20 49835	1.741 13515	23.06 65458	14.37 74887	0.779 47409	17.75 95062	1.357 92535	18.68 82995	14.53 45225	0.774 82146	19.50 88863	0.581 39729	0.428 87142
1973	Chino ok_1	0.763 37960 8	0.582 80623	0.444 90239 2	0.356 95307 6	116.9 9	125.2 3	132.2 6	143.0 5	23.87 31323	22.12 50190 9	12.91 94942	130.9 76359 8	0.758 58437 4	10.66 09592	12.74 30888	8.947 46789	11.19 22565	49.50 24414	0.707 21588	9.384 76390	8.520 97079	19.65 04100	13.56 99741	165.4 49735	0.680 68396	9.707 18828	173.1 70394	0.466 00590	0.533 99409	0.675 26960	0.825 62530	0.879 72776	5.837 58875	21.16 01359	13.72 94872	10.76 85089	2.251 71533	17.95 12141	13.99 13202	0.712 78610	11.61 45785	1.762 33914	14.46 71835	14.22 16129	0.736 82864	12.98 50540	0.507 77357	0.378 66574	
1974	Chino ok_1	0.822 89494 3	0.590 81629	0.486 17974	0.635 95010	135.3 3	141.8 2	145.6 5	143	15.70 48249	29.89 38280	13.86 56488	310.3 10581	0.786 29595	17.71 78463	7.224 39716	17.44 59920	12.31 97206	136.4 25640	0.670 06532	14.83 52867	6.057 06078	28.82 69080	14.53 78160	405.8 54034	0.776 30283	17.94 68913	412.6 49719	0.229 41808	0.770 58191	0.671 56898	0.829 46989	0.882 40444	4.211 47067	31.07 32308	14.68 45418	0.763 83217	19.51 36300	1.507 62537	26.58 1547	14.85 69634	0.809 88339	19.67 29768	1.173 21328	21.63 89789	14.98 29711	0.814 08986	21.02 83126	0.576 04516	0.387 64262
1975	Chino ok_1	0.807 6136	0.618 44507	0.499 46465	0.681 727	144.6 2	146.4 8	149.4 3	155.5	16.44 80105	29.78 27971	13.59 05195	259.0 61949	0.754 92079	15.06 56306	7.741 34502	15.45 25864	12.22 74269	119.8 23414	0.635 31932	12.78 32696	6.517 08035	27.43 50150	14.02 24863	327.9 41543	0.732 04929	14.55 76409	339.8 21929	0.199 75760	0.800 24239	0.699 69276	0.843 59055	0.894 44609	4.378 27091	29.88 54034	14.19 32855	0.743 03747	16.06 13252	1.580 99191	25.33 30060	14.43 40060	0.778 31105	16.83 23542	1.229 85457	20.63 46512	14.66 57671	0.772 91700	18.67 04311	0.569 95117	0.425 64699
1976	Chino ok_1	0.837 01880 2	0.733 79578 7	0.614 20087 1	0.623 54711 5	118.5 8	123.9 4	131.5 6	129.7	20.52 96696 3	24.25 37795	11.39 37544	259.7 89719	0.714 71439	14.23 88047	10.06 32117	13.18 74504	10.01 81839	120.2 61109	0.542 94847	11.12 33377	7.611 86404	23.17 87787	11.89 99324	329.0 21041	0.715 34884	343.9 87731	0.283 69607	0.716 30392	0.790 75176	0.881 97529	0.926 51821	5.091 92159	25.23 64295	12.11 23960	0.723 11304	15.80 70411	1.867 31338	21.50 92153	12.31 67263	0.771 82751	16.25 92315	1.456 02148	17.43 87072	12.45 41840	0.769 25018	17.93 83111	0.672 44026	0.523 95069	
1977	Chino ok_1	0.724 22708 4	0.500 54649	0.362 50933	0.239 12908	130.5 9	138.9 4	144.2 4	138.9 3	21.64 10044	23.51 69505	14.02 03372	108.8 45766	0.782 55941	10.39 94375	11.02 72518	10.26 63840	12.88 77578	38.13 77578	0.767 71552	9.647 04399	8.126 97079	20.58 40956	14.51 14482	145.4 36508	0.686 20935	9.245 68104	151.1 10839	0.560 30577	0.439 69423	0.605 71968	0.793 88777	0.853 48041	5.639 99296	22.08 85377	14.58 85345	0.728 37124	10.40 42337	2.171 68711	18.59 83362	14.70 47821	0.717 06238	11.12 71705	1.699 37284	14.98 77737	0.743 98438	12.28 13501	0.456 38231	0.279 04090	
1978	Chino ok_1	0.830 45389 8	0.729 51547	0.605 82897	0.237 40750	109.3 1	120.6 4	128.6 5	129.4 9	24.67 73468	21.62 46933	11.17 10254	202.5 64325	0.711 48618	11.73 00458	13.20 66673	10.47 52216	9.622 94043	89.03 04901	0.585 49401	9.511 81526	8.456 95027	20.48 36971	11.70 42099	260.8 63629	0.672 22513	11.27 82886	270.7 73284	0.677 96219	0.322 37380	0.790 79159	0.882 91623	5.630 73381	22.28 24031	11.90 70766	0.692 73535	12.50 42211	2.139 39747	18.84 96540	12.14 92128	0.726 95577	13.20 68939	1.672 24127	15.22 22087	12.34 42964	0.715 10216	15.24 87778	0.652 72659	0.509 69621	
1979	Chino ok_1	0.824 22044 7	0.722 18695	0.595 24125	0.245 11764	113.2 6	123.1 8	131.0 9	127.0 9	24.47 84130	21.78 48692	11.24 2661	187.2 30523	0.742 46094	11.67 22240	13.12 00277	9.932 91826	9.630 98506	71.33 05732	0.675 53110	9.696 67682	8.406 32289	20.86 33546	11.85 26732	246.0 66299	0.669 46718	11.06 58830	257.3 98407	0.669 32084	0.330 67915	0.786 85001	0.880 52673	0.926 03691	5.554 67528	22.75 84861	12.06 35112	0.699 54919	12.14 39493	2.095 45981	19.24 44399	12.29 58828	0.728 12081	13.20 54316	1.638 24445	15.53 06034	12.45 61333	0.709 49141	15.28 03249	0.661 85786	0.484 28483
1980	Chino ok_1	0.818 77098	0.607 85750	0.497 69608	0.639 82963	136.0 1	141.9 7	146.3 5	143.6 5	16.82 68975	28.87 55030	13.48 65288	257.2 49127	0.759 41998	14.57 24386	7.981 33485	16.07 34828	11.93 5602	110.6 68046	0.650 45404	12.00 98915	6.440 494																												

Columbia River System Operations Environmental Impact Statement
Appendix E: Fish, Aquatic Macroinvertebrates, and Aquatic Habitat

Year	Species	InRivSurvSNK	InRivSurvLCol	InRivSurv	ProportionTransported	MedDayLGR	MedDayConfl	MedDayBONinriv	MedDayBONtrans	meanTravelTime	meanMigRate	meanTemp	meanFlow	meanFSpill	meanGas	SNKTravelTime	SNKMigRate	SNKTemp	SNKFlow	SNKFSpill	SNKGas	LCTravelTime	LCMigRate	LCTemp	LCFlow	LCFSpill	LCGas	BonFlow	propBONinriv	propBONtrans	JDAInRivSurv	DeschInRivSurv	BONInRivSurv	JDATime	JDAMigRate	JDATemp	JDAFSpill	JDAGas	DESTime	DESMigRate	DESTemp	DEFSpill	DESGas	BONTTime	BONMigRate	BONTemp	BONFSpill	BONGas	monte_q975	monte_q025
1985	Chino ok_1	0.834 24581	0.723 07017 3	0.603 21826 2	0.248 47115 1	110.3	120.7 4	129.2 4	127.4 1	24.90 51154 8	21.36 12888 9	11.04 41235 5	180.2 53575 5	0.683 44743 1	11.18 19925	12.97 32200 4	10.67 79936 8	9.387 29724 9	98.26 40579	0.505 36126 5	9.122 68219	8.924 65919 3	19.64 97476 7	11.62 87929 2	225.2 90301	0.673 57741 8	10.76 96309 9	227.6 82800 3	0.664 81100 3	0.335 18899	0.788 37983 7	0.880 92707 2	0.926 02594 1	5.804 29881	21.49 82901 8	11.86 64886 5	0.711 76733 4	11.80 29226 3	2.225 06222 1	18.17 14781 4	12.12 12819 4	0.729 78386 3	13.04 22849 7	1.742 31371 3	14.62 65204 9	12.31 22258 2	0.701 06016 1	15.05 55138 6	0.663 22112 6	0.504 53355 4
1986	Chino ok_1	0.789 87978 9	0.607 77882 3	0.480 07220 9	0.474 79373 9	116.7 8	121.2 4	128.1 8	141.0 4	22.88 21712 7	22.90 47427 1	12.82 30128 3	195.5 26276 7	0.687 40241 2	11.90 67701 6	11.73 10132	11.74 07257 5	11.10 16038 9	102.3 70101 9	0.514 94933 4	9.690 98587	8.418 23057 1	20.25 42837 8	13.29 29932 3	242.9 16008	0.674 81563	11.48 58733 8	242.2 87109 4	0.364 98055 1	0.635 01944 9	0.703 30149 1	0.840 09245 2	5.675 69474 1	21.93 69891 6	13.46 41016	0.705 43946 6	12.58 06444 2	2.183 44215 3	18.52 69455 7	13.83 68314 1	0.726 56733 8	13.55 16503 7	1.710 81356 9	14.88 92733 9	14.18 82448 2	0.707 41982 8	15.52 27379 8	0.542 36311 4	0.407 99414 1	
1987	Chino ok_1	0.749 12439 1	0.515 09657 1	0.385 87140 5	0.277 78949 8	117.7 5	126.0 9	131.8 6	127.7 1	20.28 02446 6	23.94 79617 2	13.79 66833 1	205.6 92926 4	0.771 29554 7	12.28 1722	12.36 14261 9	12.57 43152 6	65.49 02061 5	0.743 52263 2	10.55 40205	7.444 78410 5	23.05 71249 2	14.34 46242	281.3 67665 6	0.680 08774 5	272.28 00592	0.526 79998 8	0.473 20001 2	0.626 96732 6	0.813 58431 1	0.870 74379 9	5.192 35962 6	24.78 51058 4	14.39 75742 3	0.695 19425 6	12.79 14070 1	1.934 54286 5	20.80 53040 5	14.49 57462 9	0.743 92964 4	13.54 55271 4	1.510 95849 3	16.81 30671 2	14.59 58638 2	0.738 80797 6	15.71 93555 8	0.470 78434 7	0.300 02523 5		
1988	Chino ok_1	0.804 36609 3	0.706 31696 2	0.568 13741 5	0.115 54356 6	108.9 8	121.4 5	130.0 1	134.0 7	26.83 12115 1	20.30 98412	11.17 73371 7	138.3 02622 8	0.727 80106 5	10.46 89708 9	14.76 32155 9	8.169 92516 3	9.571 56623 8	57.76 56822 7	0.652 56822 7	9.022 07698 8	9.106 70842 2	18.96 12952 2	11.75 22942 2	180.1 93527 8	0.654 39738 8	9.614 75412 8	185.6 25030 5	0.826 63996 2	0.173 36003 9	0.777 13255 5	0.875 23463 3	0.921 85797 8	5.977 74709 5	20.67 78686 5	11.94 96696 5	0.694 93180 5	10.72 44611 7	2.309 86879 8	17.52 39120 7	12.19 41458 4	0.697 31485 7	11.62 02767 7	1.809 46974 5	14.10 06931 7	12.38 94496 7	0.717 59176 3	12.98 61011 5	0.632 86854 5	0.454 99278
1989	Chino ok_1	0.784 20949 6	0.531 70693	0.416 96962	0.589 07582 2	142.7 1	149.7 6	152.3 1	147.4 9	18.66 02399 6	27.44 4631	13.81 16179 9	195.7 08763 1	0.723 50115 8	11.58 12510	9.307 98944 1	13.28 95710	12.15 11304 9	79.32 79083	0.630 56559 6	9.651 24340	7.058 51465 5	25.09 93616	14.52 20470	260.7 46871	0.662 69837 8	10.88 78692	271.7 61871	0.238 15121	0.761 84878	0.628 09380	0.813 68797	0.871 69086 3	4.772 91852	27.27 76383	14.66 05547	0.684 62286	12.14 40078	1.762 13035	22.80 68129	14.79 01700	0.720 98825	12.89 43602	1.375 07417	18.45 68212	14.91 73855	0.724 35262	14.76 73268	0.527 58415	0.299 41765
1990	Chino ok_1	0.714 38210 7	0.323 86337 4	0.231 36219 9	0.467 88006	132.6 1	140.6 5	143.8	136.9 5	18.38 93313	26.10 16991	15.47 33707	167.2 49568	0.745 37709	11.22 35061	8.757 67550	13.46 73062	14.29 70508	60.71 01966	0.701 75238	9.681 93035	7.157 60906	23.84 7278	16.17 78318	224.2 2288	0.654 41997	10.30 86177	228.5 68817	0.223 98525	0.776 01474	0.443 25704	0.713 83040	0.787 72631	5.002 91498	25.60 25052	16.20 85641	0.683 92496	11.56 99466	1.880 02281	21.39 25074	16.19 84529	12.52 54366	1.467 63055	17.30 62549	16.18 33839	0.718 06902	14.17 50304	0.373 77677	0.121 74438	
1991	Chino ok_1	0.787 40387 3	0.600 92124 2	0.473 16771 3	0.338 79789 5	120.6 8	127.8 7	134.7 6	141.0 9	22.16 43333	23.71 48432	13.02 42481	191.3 85789	0.762 81835	12.10 12378	11.80 54225	9.860 39948	11.24 76707	59.28 29032	0.712 41745	9.914 71862	7.779 85668	7.157 60906	23.84 7278	16.17 78318	224.2 2288	0.654 41997	10.30 86177	228.5 68817	0.223 98525	0.776 01474	0.443 25704	0.713 83040	0.787 72631	5.002 91498	25.60 25052	16.20 85641	0.683 92496	11.56 99466	1.880 02281	21.39 25074	16.19 84529	12.52 54366	1.467 63055	17.30 62549	16.18 33839	0.718 06902	14.17 50304	0.373 77677	0.121 74438
1992	Chino ok_1	0.730 08163 9	0.499 34076	0.364 55952	0.322 74143	119.6 9	127.1	132.0 2	132.2 5	21.68 85803	22.79 40892	13.82 24826	159.8 78758	0.740 96722	10.94 79695	10.86 55250	10.80 87310	12.72 50316	52.30 84953	0.720 51075	9.564 53609	8.046 67018	21.13 53165	14.24 28255	216.1 45502	0.628 49818	9.914 94814	222.2 16781	0.459 89695	0.540 10304	0.617 17353	0.808 55469	0.867 46507	5.528 28787	22.78 34466	14.29 10997	0.659 42571	11.15 60512	2.106 95718	19.16 86020	14.41 32992	0.681 14815	11.96 80875	1.649 30008	15.42 97184	14.55 03654	0.705 32733	13.41 35131	0.446 18863	0.282 86285
1993	Chino ok_1	0.817 45395 4	0.722 44623	0.590 56653	0.579 14905	119.2 1	126.4 5	134.4 8	129.8 8	21.70 37757	23.44 71535	11.47 85485	202.4 35116	0.742 56001	12.40 27696	10.95 39332	11.26 53832	10.40 17036	84.24 74899	0.638 10889	10.05 66146	7.953 83732	22.42 86807	11.89 23034	262.2 32172	0.700 88350	12.07 87354	291.5 57464	0.315 93305	0.684 06694	0.788 98402	0.883 27603	0.927 94328	5.216 75818	24.54 15443	12.04 81367	0.735 47217	13.24 08681	1.914 08913	20.97 37602	12.18 85188	0.763 6922	14.51 96622	1.491 61233	17.02 80135	12.27 34627	0.753 21915	16.23 99158	0.648 53445	0.490 00022
1994	Chino ok_1	0.714 54693 4	0.423 13994	0.302 35335	0.522 14056	128.3 8	136.4 8	140.5	134.8 6	19.12 12520	25.46 51484	14.45 64826	166.3 36825	0.735 58486	11.11 18548	9.225 49371	12.92 51417	13.36 71842	63.09 46342	0.680 75171	9.546 29554	7.369 44326	23.33 65772	15.01 18543	220.0 82743	0.649 07170	10.25 32072	223.3 90869	0.235 13603	0.764 86396	0.555 32613	0.787 09138	0.850 36081	5.118 12934	25.11 90262	15.01 51521	0.679 90815	11.47 28712	1.919 79455	20.98 05436	15.03 91330	0.700 86901	12.19 97826	16.92 96661	15.13 16351	0.707 22968	13.76 51209	0.401 38591	0.199 63356	
1995	Chino ok_1	0.798 61965 7	0.632 93880	0.505 47737	0.573 49777	118.8 6	123.0 7	130.3	140.3 7	22.92 14556	23.14 18674	12.65 30114	189.5 42196	0.711 42309	11.70 21642	12.00 93695	10.46 02463	10.88 97088	85.37 97088	0.571 13452	9.583 19397	8.314 40147	20.65 03215	13.24 68557	233.3 04000	0.684 04273	11.04 73851	241.5 99105	0.286 71850	0.713 28149	0.811 82192	0.844 55787	0.895 43503	5.572 30623	22.41 18539	13.45 14436	0.718 07974	12.12 31109	2.122 50991	19.00 46995	13.75 64497	0.734 56784	13.31 85863	1.659 50345	15.33 77947	14.02 20265	0.719 70474	15.42 91997	0.568 05638	0.446 79998
1996	Chino ok_1	0.777 08642 3	0.559 06028	0.434 43815	0.650 42346	137.4 4	134.6 4	138.3 5	151.2 8	16.52 41078	28.91 45045	14.27 82593	259.5 30577	0.742 70648	14.84 22006	7.516 77635	16.70 87456	13.22 27029	123.2 21907	0.617 11005	13.07 45826	6.704 76541	25.78 69274	14.54 55524	331.7 59251	0.718 72348	13.98 58768	339.1 87774	0.202 24483	0.797 75516	0.651 60652	0.822 66856	0.877 81928	4.677 04401	27.74 13383	14.67 83700	0.714 24386	15.28 27217	1.721 21752	23.31 90892	14.89 41806	0.766 67137	15.63 46174	1.341 65594	18.91 41784	15.10 88099	0.768 94226	17.76 83739	0.510 60545	0.342 84626
1997	Chino ok_1	0.821 74667 5	0.585 06936	0.480 77880	0.641 46646	132.9	135.3 3	137.9 6	140.6 3	14.79 56344	30.57 89082	13.93 53516	354.3 25095	0.795 30412	20.30 45142	6.355 93453	19.90 78696	12.40 56251	164.7 26245	0.665 11299	17.51 334	5.972 78962	28.84 99529	14.51 60600	457.6 42776	0.801 44905	20.79 04860	464.7 69500	0.223 70113	0.776 29886	0.671 79692	0.832 72114	0.884 95544	4.170 53411	31.01 62702	14.65 87875	0.785 47667	22.59 36916	1.487 75271	26.93 99510	14.87 33441	0.828 94643	22.31 49337	1.157 79639	21.93 03595	15.07 90939	0.835 30381	23.05 20029	0.557 40693	0.397 58606
1998	Chino ok_1	0.821 35752 6	0.652 15386	0.535 65148	0.484 43392	114.2 1	121.7 1	128.8 1	129.6 4	22.45 07942	22.80 22802	12.48 05613	251.3 44557	0.730 48051	13.77 08486	11.67 55679	11.06 48878	10.38 28937	94.76 07025	0.607 30028	10.33 67397	7.849 11689	22.10 08414	13.26 34450	325.1 72119	0.698 37154	13.43 00216	344.6 01348	0.381 307																					

Columbia River System Operations Environmental Impact Statement
Appendix E: Fish, Aquatic Macroinvertebrates, and Aquatic Habitat

Year	Species	InRivSurvSNK	InRivSurvLCol	InRivSurv	ProportionTransported	MedDayLGR	MedDayConfl	MedDayBONinriv	MedDayBONtrans	meanTravelTime	meanMigRate	meanTemp	meanFlow	meanFSpill	meanGas	SNKTravelTime	SNKMigRate	SNKTemp	SNKFlow	SNKFSpill	SNKGas	LCTravelTime	LCMigRate	LCTemp	LCFlow	LCFSpill	LCGas	BonFlow	propBONinriv	propBONtrans	JDAInRivSurv	DeschInRivSurv	BONInRivSurv	JDATime	JDAMigRate	JDATemp	JDAFSpill	JDAGas	DESTime	DESMigRate	DESTemp	DESFSpill	DESGas	BONTTime	BONMigRate	BONTemp	BONFSpill	BONGas	monte_q975	monte_q025		
2003	Chino ok_1	0.790 84764 9	0.614 90497 9	0.486 29615 7	0.542 70131	129.3 2	134.2 3	141.5	140.0 1	20.23 37630 5	25.31 66852 6	13.11 44111 5	198.5 28694 7	0.727 08948 8	11.95 41832	10.23 52143 5	11.94 09677	11.62 41865 2	78.95 19607 5	0.626 03409 3	9.585 57491 3	7.530 48004 2	23.20 56931 5	13.71 99581 5	257.0 45153 3	0.674 84738 9	11.32 58068 6	281.2 91015 6	0.306 62133 8	0.693 37866 2	0.701 06818 7	0.843 75983 3	0.895 54778	5.066 45287 6	25.21 10085	13.86 70578	0.705 83525 3	12.59 65824 1	1.875 89095 5	21.37 08517 8	14.05 04144	0.734 37445 4	13.64 04110 6	1.460 10734 1	17.39 13178 3	14.21 12493 5	0.734 38759 1	15.45 99556 9	0.555 85859	0.413 22192 9		
2004	Chino ok_1	0.804 40194 7	0.645 81165 8	0.519 49215 5	0.167 58016 7	107.0 9	120.4 3	128.4 4	130.5 5	26.59 65486 6	20.49 72252 6	12.05 93075 8	168.7 54279 5	0.728 76077	11.05 23596 2	14.76 73287 7	8.465 58426 2	9.708 48808 3	57.49 44534 3	0.674 14235 5	9.419 01073 5	8.810 58265 3	19.55 92520 3	12.95 20260 5	221.0 54545 1	0.638 65784 3	10.08 32375 7	244.9 50042 7	0.739 40889 9	0.260 59110 1	0.722 81676 9	0.844 50720 8	0.895 53278 1	5.838 52340 3	21.28 58364 4	13.18 95887 4	0.675 42366 4	11.20 20904 5	2.227 18338 7	18.09 07877	13.54 39157 5	0.688 96996	12.38 09245 4	1.738 57329 8	14.65 70082	13.80 78045 8	0.698 45588 5	14.06 12983 7	0.603 91226 8	0.418 04823 8		
2005	Chino ok_1	0.769 33925 9	0.567 04368 8	0.436 24897 1	0.494 99397 1	120.0 4	126.1 4	133.1 1	135.2 2	21.64 93138 4	23.34 51858 6	13.56 46763 5	169.9 94657 2	0.726 06780 3	11.21 71000 1	10.91 45196 2	10.97 04111 8	12.06 33661 3	66.20 44799 8	0.658 19272 4	9.724 02591 7	8.089 64618 3	21.14 48114 6	14.07 81507 5	218.7 29970 3	0.645 17034 6	10.21 22888	230.5 92305	0.326 07694	0.673 81184	0.660 81184	0.820 08726 9	0.875 81851	5.508 02882	22.85 80097	14.23 83029	0.677 49427	11.32 69168	2.082 64800	19.33 92986	14.47 32125	0.695 99516	12.26 06496	1.626 51609	15.64 12138	14.66 68291	0.712 34361	13.86 31067	0.517 02927	0.346 14149		
2006	Chino ok_1	0.833 89980 8	0.712 38915 9	0.594 06118 3	0.635 11835 1	119.7 8	124.5 6	131.9 9	128.5 1	20.13 30302 6	24.21 87602 6	11.60 20304 3	241.2 82714 3	0.697 97497 6	13.34 41614 1	9.563 51945 5	14.23 35864 4	10.26 81198 1	127.7 04209 9	0.516 11787	11.49 10944	7.651 86528 9	22.70 28139	12.15 00624	302.9 24189	0.698 51018	12.86 82366	313.8 28552	0.267 39512	0.732 60487	0.775 51867	0.876 28994	0.922 39025	5.196 98195	24.59 77357	12.34 00922	0.701 01730	14.01 01730	1.932 75786	20.80 14497	12.50 34929	0.753 56168	14.34 16496	1.508 07662	16.84 44649	12.59 71636	0.747 01224	16.32 86819	0.662 03033	0.512 94608		
2007	Chino ok_1	0.776 95569 6	0.582 10714 2	0.452 27145 9	0.478 74320 9	119.0 5	125.4 6	131.7 7	131.6 6	21.72 15873 7	23.15 01388	13.37 35517	195.7 76740	0.747 34493	11.77 38596	11.14 43495	11.06 36492	11.91 09314	68.46 04026	0.676 16345	9.600 76942	7.771 77829	21.98 43836	13.94 20967	259.4 08691	0.680 33576	11.14 88306	269.9 19891	0.349 61554	0.650 38445	0.669 71157	0.826 71945	0.881 15487	5.335 34617	23.71 55838	14.08 99765	0.700 83047	12.49 52096	2.012 45857	19.99 93771	14.27 19265	0.733 34369	13.31 78192	1.571 26153	16.17 88233	14.41 31164	0.722 56444	15.40 92345	0.534 27023	0.364 33435		
2008	Chino ok_1	0.805 10092 1	0.719 22768 9	0.579 05087 4	0.228 30872 7	103.0 5	117.0 9	125.9 3	131.7 5	27.07 16754 7	17.15 41622	11.15 89086	149.2 16761	0.731 38947	11.12 88788	14.65 65498	8.439 72738	9.693 62297	60.92 28324	0.596 49643	8.967 47798	9.280 79532	18.37 20598	11.54 78445	185.6 97176	0.709 49507	10.69 37891	195.6 66015	0.681 70361	0.318 29638	0.784 28063	0.877 24893	0.922 15855	6.110 77375	19.99 21732	11.75 05419	0.756 69944	11.71 88013	2.375 92247	17.03 39571	12.07 35522	0.744 73964	13.03 60078	1.860 55471	13.72 72440	12.35 59315	0.727 18732	14.97 86840	0.641 59224	0.499 2		
SCN MO4-RESSIM																																																				
1929	Chino ok_1	0.805 47711 8	0.638 19796	0.514 05385 3	0.059 65140 4	126.4 7	135.8	142.1 7	132.7 6	19.37 82235 5	25.99 87453	12.88 27108	161.2 65721 5	0.965 08925 7	15.80 18121 4	9.898 08945	12.28 52891	11.60 86914	61.44 04251	0.963 87919	13.18 62627	7.094 07075	23.62 90375	13.44 42472	211.7 84980	0.948 64274	16.45 53954	225.2 42523	0.898 07628	0.101 92372	0.702 26508	0.838 51228	0.887 54433	5.136 94437	25.03 63368	13.58 47703	0.950 08195	18.75 81621	1.905 94320	21.07 48074	13.69 43794	0.937 06631	19.92 58842	1.486 00172	17.09 24501	13.75 92229	0.933 47269	21.16 99161	0.591 74738	0.403 61960		
1930	Chino ok_1	0.807 39805 4	0.621 27881 8	0.501 61930	0.017 27173 8	103.8 8	118.4 1	125.3 8	136.2 8	24.40 48748 8	20.19 19808	12.07 50282	141.5 47607	0.957 3434	15.02 71945	12.83 43777	9.862 95928	10.18 33444	63.09 50187	0.960 36564	13.57 07107	8.313 42502	19.23 01955	12.78 44635	179.5 71052	0.933 49665	15.07 66397	190.5 87097	0.968 96846	0.031 03153	0.690 11256	0.829 35734	0.878 80812	6.071 14287	20.17 97481	12.94 79948	0.938 78737	17.01 45685	2.368 00985	17.10 55143	13.19 85321	0.923 86694	18.01 58510	1.855 48561	13.76 13710	13.41 23315	0.920 33299	19.49 20749	0.569 82126	0.404 68346		
1931	Chino ok_1	0.792 17516 6	0.617 62455 1	0.489 26683	0.015 97847	105.7 8	120.7 8	127.5 9	141.5 9	25.90 77642	19.98 80114	12.14 02101	140.1 39713	0.948 99813	14.46 85793	14.48 82787	8.344 06947	9.989 02263	44.30 31578	0.941 77922	11.48 68578	8.239 48497	19.54 62654	13.02 31275	185.5 04854	0.929 51319	15.26 01323	200.7 86804	0.970 83738	0.029 16262	0.685 35																					

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1941	Chino ok_1	0.756 40713 6	0.471 62865 7	0.356 74328 2	0.041 77414 2	133.5 1	139.9 8	140.7 5	143.7	18.64 50986 6	25.93 79120 2	14.54 41066 2	160.2 34868 2	0.965 22546 2	15.88 32607 3	9.184 69817 9	13.17 43820 9	13.38 34730 1	60.14 24179 1	0.964 71180 9	13.35 50561 9	7.000 37857 1	23.55 42104 3	15.07 43823 1	212.9 18416 3	0.948 26616 8	16.56 37939 8	220.0 67611 7	0.901 58090 6	0.098 41909 6	0.568 20285 9	0.774 15082 2	0.833 85001 3	5.153 09592 3	24.74 92180 5	15.13 22391 5	0.948 93709 6	19.02 59456 6	1.942 14337 3	20.73 15518 8	15.21 84149 4	0.935 33132 5	20.00 48669 2	1.517 30819 8	16.74 48204 1	15.29 75540 2	0.931 29783 9	21.17 63601 3	0.447 81672 6	0.265 38899 4	
1942	Chino ok_1	0.829 81731	0.645 37394 7	0.535 54247 2	0.056 27623 9	136.4	144.2	149.1 9	147.6 5	17.67 34063	27.70 97681	12.96 86051 8	203.6 37081 1	0.969 62713 8	18.19 41258 2	8.687 30653 8	14.40 17341 1	11.63 54835 5	90.19 74990 8	0.973 69550 5	16.24 66926 6	6.614 91356 8	25.69 59191 6	13.56 55571 6	263.3 82415 8	0.951 05055	18.68 52969 3	271.2 67944 3	0.905 97521 4	0.094 02478 6	0.708 87548 3	0.843 01529 1	0.891 44755	4.736 29938 1	4.736 79056 3	27.37 13.70	13.70 78371	0.947 20403	21.15 46787 3	1.751 92405 3	22.92 66915 5	13.82 09285	0.929 75376	21.91 36714 9	1.366 43089 4	18.57 27657 3	13.90 10663	0.918 04963 4	22.63 18874 4	0.605 17601 7	0.457 04324 2
1943	Chino ok_1	0.846 10392 7	0.655 43677 3	0.554 56762 8	0.045 09489 5	124.0 9	130.7 1	135.5 3	130.0 9	19.47 32461 2	23.93 50331 9	12.28 53774 3	218.5 93959 3	0.958 46355 4	18.78 48400 4	9.166 84938 2	13.81 80519 8	10.68 54457 9	111.4 20996 1	0.953 77730 1	17.73 07819 4	7.391 59573 6	22.38 04550 6	12.92 77760 2	273.6 24008 2	0.941 60074	18.82 77356 9	284.4 77356	0.925 49014 9	0.074 50985 1	0.712 42043 4	0.839 63585 7	0.887 90118 4	5.352 87250 6	23.67 08561 8	13.11 82094 6	0.935 79915 8	21.16 81091 3	2.016 26850 7	19.97 36178 5	13.31 83641 4	0.915 69336 3	21.67 54194 9	1.575 07856 2	16.13 99622 1	13.46 95363 3	0.901 15824 3	22.51 45435 3	0.639 70816 5	0.457 33431	
1944	Chino ok_1	0.804 72794 5	0.594 50871 7	0.478 41777 8	0.047 44646 8	131.4 1	139.6 5	145.9 7	136.4 1	18.33 31037 6	26.95 31927 1	13.50 70714 3	158.5 65122 9	0.966 52144 6	15.95 912	9.109 97862 4	13.01 09997 8	12.10 11783 6	67.90 70632 9	0.970 38492	14.09 91155 3	6.933 35477 3	24.13 25916 8	14.10 26326 8	207.7 83200 6	0.946 56215 1	16.34 57282 4	211.8 65478 5	0.912 58492 1	0.087 41507 9	0.662 35093 5	0.817 24397 4	0.869 08781 1	5.038 42309 1	25.53 16830 1	14.25 23025 5	0.946 76551 8	18.68 52882 4	1.884 57108 3	21.35 16083 2	14.39 54696 7	0.932 60322	19.60 08307 1	1.471 80420 9	17.25 52726	14.51 01733	0.928 44650 2	20.80 71527 5	0.569 86597 3	0.360 20645 3	
1945	Chino ok_1	0.832 21293 9	0.640 35925 3	0.532 91525 6	0.036 23953 9	119.8 9	128.8 4	135.2 8	130.6 2	19.71 64967 6	24.85 29080 8	12.65 41756 1	182.1 70106 1	0.966 98937 7	17.27 36626 4	9.784 62415 2	13.02 83014 1	10.95 54918 3	82.78 56170 7	0.964 48253 4	15.04 56359 9	7.306 60522 7	22.76 34851 7	13.32 60259 6	231.9 69866	0.952 57389	17.82 82396	244.9 61212	0.938 16737	0.061 83262	0.702 19466	0.832 70777	0.881 43788	5.296 39352	24.08 53085	13.51 14164	0.953 37115	19.92 49054	1.980 68548	20.30 64119	13.73 64365	0.940 57611	21.01 32897	1.545 70216	16.44 19536	13.90 05503	0.936 18446	22.07 05938	0.602 29989	0.434 25064	
1946	Chino ok_1	0.864 02540 3	0.731 33397 5	0.631 89113 2	0.016 02106 9	111.8 3	120.6 8	128.0 1	128.1 5	20.23 89333	23.32 24121	11.28 72777	256.1 75788 9	0.960 46398 8	20.07 16349 4	9.588 27864 4	13.79 93362	9.639 43996	118.2 56246	0.969 36985	18.55 75786	7.552 73006	22.24 37014	11.85 06156	326.2 07204	0.933 27499	20.45 71824	339.8 32000	0.976 24816	0.023 75183	0.778 54128	0.870 44469	0.913 93662	5.376 48103	23.70 80682	12.06 70166	0.922 85209	22.96 36867	2.004 74942	20.06 56775	12.33 24705	0.896 36498	23.19 40326	1.564 59877	16.24 54184	12.51 66678	0.872 42677	23.60 70194	0.689 35272	0.536 58304	
1947	Chino ok_1	0.843 92753 9	0.628 06902 6	0.530 04474 7	0.054 21326 1	111	121.9 5	128.6 1	130.0 9	20.68 41744	23.33 19469	12.46 76006	240.8 16546	0.960 86795	19.04 13581	10.26 83518	12.89 91978	9.639 43996	118.2 56246	0.969 36985	18.55 75786	7.552 73006	22.24 37014	11.85 06156	326.2 07204	0.933 27499	20.45 71824	339.8 32000	0.976 24816	0.023 75183	0.778 54128	0.870 44469	0.913 93662	5.376 48103	23.70 80682	12.06 70166	0.922 85209	22.96 36867	2.004 74942	20.06 56775	12.33 24705	0.896 36498	23.19 40326	1.564 59877	16.24 54184	12.51 66678	0.872 42677	23.60 70194	0.689 35272	0.536 58304	
1948	Chino ok_1	0.839 12973 1	0.605 56971 6	0.508 15155 3	0.199 77103 5	132.6 2	137.3 4	141.6 9	146.8 8	15.02 90601	30.75 94640	13.68 15422	336.5 60759	0.934 46072	22.02 42169	6.789 69682	17.99 78446	12.22 38977	137.9 52279	0.925 77563	19.05 54435	5.930 90584	29.08 59060	14.24 94429	422.6 96502	0.908 92882	22.83 43044	440.7 89764	0.686 27814	0.313 72185	0.685 64649	0.838 03876	0.888 18628	4.200 01139	31.15 08422	14.38 43141	0.896 98215	25.59 81159	1.489 84240	26.87 18729	14.56 21697	0.889 78417	25.83 63933	1.158 19986	21.92 22006	14.72 83582	0.875 27287	25.82 19318	0.585 56985	0.424 49711	
1949	Chino ok_1	0.831 31804 1	0.573 91125 9	0.477 10278 4	0.137 18584 5	126.7 8	132.7 7	138.2 2	136.2 3	15.56 16132	29.39 97743	13.75 19729	284.4 87266	0.941 23112	20.30 13832	6.840 77609	18.22 01735	12.42 75764	126.0 68325	0.946 82028	18.64 30992	6.256 24503	27.46 86245	14.43 86245	360.6 41250	0.907 18931	20.63 56989	385.0 66497	0.763 98670	0.236 01329	0.659 50769	0.828 71137	0.881 72904	4.502 11753	29.25 62526	14.52 35948	0.895 69693	23.00 25966	1.600 38744	24.98 94906	14.57 49842	0.870 63429	23.26 87409	1.243 23611	20.41 17810	14.61 95430	0.846 41960	23.62 85247	0.557 84952	0.365 27577	
1950	Chino ok_1	0.835 47232 9	0.654 57097 6	0.546 87593	0.048 87198 2	132.9 7	139.8 4	145.5 7	139.5 3	16.97 67546	28.42 55948	13.03 98756	224.5 84725	0.967 50826	18.81 08901	8.141 86327	15.13 77614	11.70 21560	95.62 95288	0.977 60125	16.92 38239	6.484 10150	26.51 87018	13.57 72848	289.0 98765	0.942 85162	19.23 94656	305.9 96185	0.918 90015	0.081 09984	0.716 21345	0.845 36836	0.893 52989	4.630 26127	28.31 90442	13.73 91206	0.936 32506	21.82 51152	1.682 30032	23.80 82969	13.90 07663	0.913 04991	22.49 05815	1.308 78341	19.38 80174	14.00 49905	0.893 79888	23.09 31272	0.631 48952	0.438 78844	
1951	Chino ok_1	0.841 98473 1	0.626 84154	0.527 79100 5	0.064 50147 4	131.5 3	138.0 9	143.4 3	139.3 1	16.43 38612	28.69 72568	13.37 18630	265.3 11873	0.956 35483	19.95 97146	7.726 44189	16.11 91947	11.83 02883	108.7 38432	0.973 64305	18.04 98661	6.255 13260	27.45 23220	14.04 47912	348.2 74826	0.920 12585	20.49 04120	360.0 87677	0.890 19200	0.109 80799	0.692 51923	0.836 97096	0.887 14944	4.473 87962	29.29 66227	14.20 29493	0.908 76095	23.17 93178	23.17 60154	24.73 54730	14.34 60830	0.884 72159	23.29 60154	1.262 03804	20.10 66646	14.45 37421	0.861 86177	23.63 89808	0.602 08160	0.436 77762	
1952	Chino ok_1	0.871 02585 8	0.704 39966 2	0.613 55032	0.212 83260 3	125.6 9	131.1 8	136.5 2	134.2 1	16.37 63535	27.70 91380	12.84 16844	292.5 71091	0.927 3085	20.98 02842	7.011 59633	18.30 98256	10.84 95288	158.7 77407	0.900 16940	19.80 24601	6.665 85075	25.68 77400	12.63 76047	362.1 11902	0.913 57776	21.32 99964	375.4 16534	0.705 02490	0.294 97509	0.759 01534	0.867 40396	0.912 79858	4.730 58389	27.46 92960	12.80 94118	0.900 58004	23.43 60988	1.723 24039	23.27 91664	12.95 12939	0.874 66869	23.45 79035	1.342 57053	18.90 10644	13.04 16278	0.849 08735	23.73 83184	0.673 55199	0.520 23302	
1953	Chino ok_1	0.832 77788 8	0.660 53639	0.550 08010	0.048 68286	132.7 6	140.4 4	146.7 9	148.2 8	18.33 60317	26.80 52299	12.79 74172	218.9 7335	0.961 88341	18.30 80903	9.183 06031	13.45 39846	11.30 16309	88.50 18081	0.969 44594	16.14 82452	6.691 07473	25.35 61644	13.44 61552	282.2 68000	0.936 52311	18.78 35120	297.5 58654	0.920 23860	0.079 76139	0.721 60936	0.848 01069	0.895 51088	4.775 52676	27.03 68583	13.59 24924	0.932 53822	21.31 84478	1.753 71778	22.87 76788	13.74 99313	0.913 39574	22.01 70847	1.366 42510	18.57 27402	13.87 19558	0.899 82819	22.72 58291	0.605 28119	0.478 37651	
1954	Chino ok_1	0.834 61877 1	0.659 02969	0.550 03855	0.080 97287	140.4 3	146.2 6	149.8 9	143.7 9	17.10 21579	28.57 39711	12.94 44094	238.6 61634	0.960 09865	19.10 01339	8.452 56275	14.50 77763	11.55																																	

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Appendix E: Fish, Aquatic Macroinvertebrates, and Aquatic Habitat

Year	Species	InRivSurvSNK	InRivSurvLCol	InRivSurv	ProportionTransported	MedDayLGR	MedDayConfl	MedDayBONinriv	MedDayBONtrans	meanTravelTime	meanMigRate	meanTemp	meanFlow	meanFSpill	meanGas	SNKTravelTime	SNKMigRate	SNKTemp	SNKFlow	SNKFSpill	SNKGas	LCTravelTime	LCMigRate	LCTemp	LCFlow	LCFSpill	LCGas	BonFlow	propBONinriv	propBONtrans	JDAInRivSurv	DeschInRivSurv	BONInRivSurv	JDATime	JDAMigRate	JDATemp	JDAFSpill	JDAGas	DESTime	DESMigRate	DESTemp	DEFSpill	DESGas	BONTTime	BONMigRate	BONTemp	BONFSpill	BONGas	monte_q975	monte_q025
1959	Chino ok_1	0.818 60080 5	0.565 98620 1	0.463 31676	0.044 03707 7	137.0 2	144.2 5	148.1 7	144.7 1	16.93 63861	28.75 37842 3	13.86 16315 3	232.1 70514 8	0.965 67779 4	18.72 80856 2	8.350 41394 8	14.68 55995 9	12.19 10699 8	84.86 48254 4	0.978 35018 6	16.08 27713	6.260 51499 7	27.36 71660 7	14.64 04167 8	308.2 42243	0.937 95679	19.53 07190	320.0 20935	0.915 58454	0.084 41545	0.644 25386	0.816 18794 5	0.870 23361 6	4.490 65627 9	29.17 09617 3	14.76 40306	0.930 55962 3	22.42 58602	1.635 42857	24.51 02778 2	14.87 43089	0.910 68899	22.96 54661 6	1.273 27432 5	19.92 88061	14.95 34363 7	0.893 33823 3	23.38 43269 3	0.554 65771	0.359 81333 2
1960	Chino ok_1	0.824 82895 1	0.615 03352 9	0.507 29746 1	0.049 75736 1	135.3 6	142.1 3	147.6 1	139.1 6	17.60 96707 6	27.70 29386 3	13.24 56972 3	205.9 31197	0.970 05669 6	18.10 24725 1	8.673 68526	13.99 26636 4	11.69 74647 5	83.84 40826 4	0.976 98116 3	16.00 47493	6.579 72615 2	25.84 99694 9	13.97 43380	267.4 72183	0.949 31503	18.56 84218	279.8 6026	0.912 13573	0.087 86426	0.681 83545	0.831 06868 7	0.881 45608 8	27.49 36769	14.11 67339 3	0.944 72041	21.26 9767	1.737 62413 1	23.07 87115 1	14.22 97576 3	0.927 17435	22.00 11774 7	1.353 32211 1	18.75 81435	14.31 88157 1	0.915 90839 6	22.74 87564 1	0.591 26193 6	0.409 38969 6	
1961	Chino ok_1	0.809 51793 9	0.632 05876 9	0.511 66291 2	0.041 89382	119.7 2	129.4 3	136.1 6	132.8 5	20.70 29401 7	24.09 35050 1	12.77 93423 1	199.2 94261 9	0.963 13794 6	16.95 89323 7	10.87 06400 9	11.16 00674 3	11.02 64637	63.78 77395 6	0.969 57904 1	13.79 94607	7.116 48722	23.35 68379 1	13.58 52567 4	266.8 53230	0.939 33968	17.88 72075	278.0 11688	0.927 23193	0.072 76806	0.696 34941	0.835 49857	0.885 04057	5.158 3056	24.71 14855	13.73 77960	0.935 48897	20.62 54100	1.919 2096	13.88 10790	0.919 81383	21.56 50774	1.498 81435	16.94 75206	13.98 48237	0.909 84150	22.38 56210	0.585 25865	0.423 17229	
1962	Chino ok_1	0.836 31048 4	0.650 94447 9	0.544 39169 2	0.025 93773 1	120.1 9	128.9 2	135.2 1	129.3 1	19.05 96906 7	24.88 11766 6	12.57 85404	191.9 97607	0.974 04906	18.03 25223	9.138 76748	13.35 93762	10.91 84499	87.69 83245	0.980 18709	16.59 09078	7.243 78825	23.02 48447	13.21 48184	249.3 74496	0.955 95927	18.27 71987	252.6 49475	0.956 70456	0.043 29543	0.708 93149	0.835 65174	0.883 76415	5.252 87808	24.36 76172	13.41 87686	0.953 04025	20.81 75937	1.968 67953	20.47 47089	13.65 21911	0.938 80991	21.64 92099	1.539 41054	16.50 77994	13.82 14736	0.931 86301	22.38 34600	0.629 24773	0.442 19958
1963	Chino ok_1	0.821 82735	0.605 08456 3	0.497 27504	0.030 81914	119.1 8	128.4	134.7 7	136.7	20.40 51348	23.98 15223	12.91 42097	182.1 78121	0.967 47916	16.95 92530	10.33 67482	12.12 36140	11.12 13890	75.76 62216	0.970 17417	14.69 74617	7.327 65533	22.50 47969	13.73 49785	236.1 46848	0.948 97339	17.50 41970	244.9 63858	0.944 20158	0.055 79841	0.672 39318	0.823 86746	0.875 05980	5.344 19896	23.73 13006	13.88 47396	0.948 22523	19.89 77981	2.011 93901	20.02 69807	14.02 82719	0.933 04208	20.89 78563	1.572 42678	16.16 72505	14.13 65842	0.925 80694	21.88 72089	0.570 35456	0.409 38177
1964	Chino ok_1	0.842 58206 4	0.589 19670 9	0.496 44657 9	0.103 73080	134.1 8	141.3 1	147.0 1	144.2 1	15.87 32503	30.27 16815	13.75 56944	236.8 91397	0.959 66905	19.21 77846	7.442 93824	17.02 48979	11.98 82560	109.6 99063	0.962 31035	17.43 54591	6.187 25140	27.95 60092	14.57 09970	302.4 23563	0.937 30277	19.70 16673	312.7 78656	0.820 79919	0.179 20080	0.660 24819	0.820 66765	0.872 93856	4.426 95708	29.85 76348	14.72 58474	0.929 84606	22.03 39897	1.603 38850	25.00 22333	14.87 21561	0.907 43293	22.63 31412	1.248 40073	20.32 68427	14.98 13323	0.888 12771	23.10 97936	0.594 32115	0.369 26976
1965	Chino ok_1	0.810 29659 4	0.507 71947	0.411 40335	0.166 77419	144.5 4	147.6 1	147.0 6	159.0 6	14.76 94152	30.98 36290	14.22 09621	260.7 90906	0.946 60546	20.21 05890	6.334 08369	19.66 16939	13.31 06245	132.5 50018	0.935 33787	18.83 48644	6.145 67450	27.99 33846	14.64 47501	326.7 00083	0.929 97339	20.52 75940	334.3 71673	0.688 30680	0.311 69319	0.613 89867	0.816 96442	0.871 42594	4.409 94576	29.85 02672	14.66 4324	0.920 5	22.87 20653	1.599 01157	25.09 01157	14.69 13363	0.899 88154	1.246 68452	20.35 96550	14.78 70497	0.881 35907	23.52 60155	0.483 32168		
1966	Chino ok_1	0.810 86395 6	0.677 47694	0.549 34163	0.022 37577	111.8 6	124.3 2	130.9 5	127.3 9	22.60 17842	22.00 15445	11.73 93623	166.2 58328	0.966 61228	16.11 51013	11.85 75508	10.31 35671	10.47 91446	61.28 87252	0.967 51323	13.57 19947	7.803 16034	20.97 36580	12.23 45887	219.0 30344	0.949 16823	16.68 55553	230.0 35522	0.963 49199	0.036 50800	0.738 31914	0.856 16356	0.902 13473	5.649 59421	22.15 25825	12.37 53990	0.949 72543	19.17 10615	2.152 69210	18.74 22709	12.51 84227	0.936 12084	20.25 40791	1.683 20512	15.12 59324	12.63 29031	0.931 59180	21.38 21029	0.615 86982	0.457 12978
1967	Chino ok_1	0.824 04389	0.704 72444	0.580 72386	0.074 05828	126.2 5	135.9 2	142.1 6	134.1 5	19.40 20660	26.41 70402	12.14 37019	212.7 43294	0.955 90131	17.15 48879	10.22 87703	12.05 17937	10.94 03734	71.22 44781	0.960 82006	13.75 69690	6.726 39252	25.46 32269	12.62 04145	283.1 63653	0.929 75349	18.30 64284	298.8 91357	0.886 66084	0.113 33915	0.759 70423	0.866 61380	0.911 42147	4.772 21812	27.23 23511	12.77 37016	0.925 09076	20.90 57113	1.739 14866	23.06 15763	12.91 07036	0.905 05969	21.72 39004	1.354 67822	18.73 30175	13.00 77953	0.889 87336	22.37 8736	0.641 52698	0.481 84064
1968	Chino ok_1	0.748 75552 1	0.424 40702	0.317 77710	0.044 81514	140.6 6	146.8 2	149	148.4 4	16.63 04312	28.79 18317	15.21 01552	192.5 17948	0.966 65428	17.26 61302	7.958 72986	15.33 07756	14.24 06238	73.47 92770	0.971 55268	14.79 20734	6.410 00763	26.15 20090	15.68 99704	253.8 02963	0.945 89965	17.94 36996	264.8 44360	0.883 06020	0.116 93979	0.531 53293	0.767 68188	0.829 91367	4.687 84002	27.61 11519	15.70 34105	0.943 22912	20.57 58949	1.737 85296	23.07 69811	15.73 09589	0.926 42714	21.27 29066	1.353 56793	18.74 84733	15.79 15649	0.917 04866	22.09 34972	0.424 44045	0.215 85773
1969	Chino ok_1	0.852 52846	0.651 84619	0.555 71743	0.065 75577	117.6 3	125.5	131.9 9	137.1 5	18.73 68837	24.97 94402	12.60 03316	260.2 80494	0.956 14457	19.86 96741	8.840 39987	14.39 00306	10.68 16186	114.0 84175	0.965 32207	18.24 98142	7.054 74217	23.76 82910	13.41 82910	332.6 55410	0.926 57003	20.20 92905	341.9 21386	0.893 59620	0.106 40379	0.711 11796	0.841 30906	0.890 01566	5.076 85144	25.23 72291	13.62 32154	0.916 92391	22.79 10247	1.872 02473	21.47 70635	13.83 79367	0.895 88287	23.18 93499	1.461 95798	17.37 12479	13.98 73486	0.876 59692	23.51 44710	0.625 51216	0.455 87366
1970	Chino ok_1	0.833 99432	0.674 37381	0.562 42393	0.103 54276	126.8 4	133.9 7	140.0 8	148.8 6	18.70 80265	26.45 22789	12.46 53669	209.7 66199	0.952 86031	17.80 92153	9.375 03751	13.18 62142	11.14 08071	94.71 48223	0.948 55140	15.76 51416	6.892 81597	24.52 71937	13.01 62617	265.1 36459	0.932 88151	18.30 93095	273.2 39288	0.838 94854	0.161 05145	0.738 94994	0.856 01964	0.902 31892	4.923 29540	26.13 50076	13.15 16557	0.931 05512	20.51 41044	1.820 93092	22.07 01981	13.30 44296	0.912 6958	21.27 17736	1.420 77799	17.86 74976	13.41 84699	0.900 33581	22.07 61518	0.617 29289	0.484 87803
1971	Chino ok_1	0.855 39724	0.601 73489	0.514 72237	0.288 33789	139.3 9	145.7 9	148.3 8	140.8 2	13.84 68319	32.88 23658	13.77 45727	329.8 78977	0.910 10477	21.49 26685	5.985 3452	20.74 16820	12.41 21631	154.0 03659	0.893 82902	19.55 84499	5.577 69578	31.45 70937	14.43 29503	425.2 90664	0.878 72048	21.99 07697	429.0 46478	0.573 45645	0.426 54354	0.680 19976	0.836 16294	0.888 07618	3.904 59483	33.86 66546	14.54 59756	0.866 56695	24.26 94103	1.375 73991	29.14 14037	14.62 46109	0.861 14649	24.21 05999	1.070 28217	23.75 72630	14.66 54470	0.844 24424	24.38 26049	0.601 72475	
1972	Chino ok_1	0.851 97735	0.623 09937	0.530 86655	0.126 96334	125.0 9	130.9 4	136.7 4	153.0 4	16.41 01611	28.50 63911	13.32 33116	299.9 97789	0.940 04216	20.81 19209	7.647 84234	16.26 90975	11.46 49251	123.2 12835	0.949 06384	18.62 58651	6.291 84576	27.07 02448	14.14 22645	386.9 38985	0.902 54550	21.26 82841	389.7 80670	0.795 13213	0.204 86786	0.692 12751	0.836 09813	0.886 57030	4.488 49531	28.88 28085	14.30 58767	0.891 28433	23.85 11810	1.619 65381	24.77 06590	14.47 88303	0.886 23092	24.09 58881	1.262 00752	20.10 71605	14.60 73660	0.873 			

Columbia River System Operations Environmental Impact Statement
Appendix E: Fish, Aquatic Macroinvertebrates, and Aquatic Habitat

Year	Species	InRivSurvSNK	InRivSurvLCol	InRivSurv	ProportionTransported	MedDayLGR	MedDayConfl	MedDayBONinriv	MedDayBONtrans	meanTravelTime	meanMigRate	meanTemp	meanFlow	meanFSpill	meanGas	SNKTravelTime	SNKMigRate	SNKTemp	SNKFlow	SNKFSpill	SNKGas	LCTravelTime	LCMigRate	LCTemp	LCFlow	LCFSpill	LCGas	BonFlow	propBONinriv	propBONtrans	JDAInRivSurv	DeschInRivSurv	BONInRivSurv	JDATime	JDAMigRate	JDATemp	JDAFSpill	JDAGas	DESTime	DESMigRate	DESTemp	DEFSpill	DESGas	BONTTime	BONMigRate	BONTemp	BONFSpill	BONGas	monte_q975	monte_q025
1977	Chino ok_1	0.736 98464 1	0.521 88964 8	0.384 62465 5	0.089 91942	130.9 7	139.5 3	144.2 1	140.0 5	20.67 35590 2	24.39 65096 2	14.02 10218 5	120.3 68081 5	0.945 73094 2	13.29 77806 5	10.76 16793 8	10.79 03810 4	12.83 69146 3	38.26 71943 7	0.940 37096 5	10.79 43746 6	7.466 77175 9	21.78 22016	14.55 12692 1	163.8 36026 5	0.923 06334 8	13.94 45203 1	168.8 56796 3	0.812 72448	0.187 27552	0.603 89974 9	0.790 03312 9	0.847 19933 1	5.490 95252 9	22.85 15294 7	14.63 87224 2	0.928 38282 6	16.10 78624 7	2.102 02432 4	19.19 60136 5	14.73 53363 5	0.911 44279 6	16.84 68300 5	1.644 10353 5	15.47 85078 5	14.81 99291 2	0.908 19498 5	18.23 39048 4	0.483 34629 8	0.292 87411 8
1978	Chino ok_1	0.847 03200 4	0.716 15381 8	0.606 60520 3	0.015 71840 2	110.3 5	121.3 5	128.6 3	129.7 4	21.93 24848 4	22.17 08511 6	11.25 87274 1	201.1 87384 5	0.973 70048 1	18.39 36965 8	11.06 19423 9	11.93 71086 7	9.738 74092 1	9.979 81579 6	16.79 86649 2	13349 13349 2	7.767 21285 3	21.14 84700 6	11.86 45639 4	258.1 84015 9	0.955 41290 4	18.64 85692 7	268.3 82171 6	0.975 97555 2	0.024 02444 8	0.766 71117 3	0.865 78978 2	0.909 73828 3	5.596 48035 5	22.38 62062 8	12.03 60059 7	0.951 71365 7	21.12 79895 8	2.131 43764 4	18.92 30683 8	12.21 18854 5	0.936 08844 3	21.91 3414 3	1.666 35046 9	15.27 42647 1	12.34 99291 2	0.926 85025 9	22.69 60325 2	0.660 12100 8	0.515 59426 1
1979	Chino ok_1	0.837 34066 3	0.719 28462 2	0.602 28626 2	0.013 8146	113.4 7	123.8	131.1	129.2 1	22.29 14242 4	22.46 59442 3	11.31 60475 1	182.4 16118 9	0.967 81011 1	17.04 71990 1	11.60 08603 3	11.07 98156 7	9.690 93875 9	73.43 45634 5	0.968 87909 2	14.37 26631 2	7.757 44319	21.35 39024 9	11.94 39024 9	238.6 43765 8	0.950 82433	17.83 06812 4	250.2 55493 2	0.979 10572 5	0.020 89427 5	0.769 63055 8	0.865 18864 5	0.908 96495 4	5.567 67797 5	22.66 44499 5	12.13 81860 7	0.951 54658 6	20.20 22914 9	2.103 82506 3	19.16 95127 6	12.35 15888 8	0.937 29976 8	21.23 05812 8	1.644 99726 7	15.46 82823 7	12.49 72095 5	0.930 79936 5	22.11 08579 6	0.672 68589 4	0.496 60988 2
1980	Chino ok_1	0.843 62887 8	0.611 43363 9	0.515 82307 5	0.065 68604 1	137.1 3	143.9 9	148.5	144.8 5	15.57 78050 9	30.27 34170 8	13.55 18140 8	247.5 75478 7	0.962 85313 8	19.89 26513 8	7.142 54172 1	17.31 64018 8	11.99 23742 9	111.0 92681 2	0.974 07162 2	18.22 06337 1	6.156 15633 4	28.15 84618 7	14.28 40666 7	323.0 06586 7	0.934 93147 7	20.41 75527 7	325.7 15118 4	0.885 60865	0.114 39135	0.679 66576 7	0.829 95625 1	0.880 91771 2	4.400 66674 4	30.09 04797 5	14.43 18460 5	0.926 04826 7	22.97 79644 7	1.596 57463 4	25.12 66554 8	14.55 02907 4	0.905 29904 8	23.09 26418 3	1.243 90351 8	20.40 06455 4	14.63 20166 6	0.886 95636 4	23.43 19019 3	0.586 82011 7	0.431 40410 7
1981	Chino ok_1	0.796 35519 2	0.537 04474 2	0.427 67836 9	0.046 52605 6	128.3 8	134.6 3	134.3	151.4 3	19.34 81492 3	24.62 51749 8	13.84 97928 2	196.3 55648 6	0.961 93698 9	17.48 60872 5	9.544 56764 5	13.15 19028 6	12.58 69476 3	83.36 64001 3	0.964 53102 8	15.36 69178	7.054 07784 9	23.23 14.38	254.9 59505 7	0.940 74402 3	18.00 30949 5	261.8 88824 5	0.904 50322 8	0.095 49677 2	0.620 59691 2	0.803 16368 2	0.858 59010 1	5.140 15983	24.49 05975 4	14.47 98833 8	0.938 91968 7	20.36 38473 5	1.956 82598 7	20.59 00963	14.58 31184 4	0.922 47585 5	21.04 28473 2	1.529 66024	16.61 09428 3	14.68 45803 3	0.913 49667 3	21.94 52190 4	0.509 59028 4	0.347 33807 9	
1982	Chino ok_1	0.833 02807 3	0.531 65759 7	0.442 88570 3	0.153 28698 8	142.8 5	146.8 1	147.8 1	166.2 1	14.64 85570 1	31.76 72576 8	14.51 31220 1	280.2 67391 2	0.942 36332 6	20.44 71140 6	6.561 15822 5	18.91 76128 2	13.15 78960 4	127.5 42976 4	0.943 06086 3	18.71 83990 5	5.877 05560 8	29.45 11547 8	15.10 51481 6	359.9 08035 3	0.912 96407 6	20.92 34856	362.8 19122 3	0.722 99604 7	0.277 00395 3	0.617 58902 2	0.806 69368 1	0.862 72825 4	4.182 46492	31.50 87552 1	15.21 62338 3	0.902 81189 7	23.26 67366	1.504 90853 9	26.65 90685 1	15.32 71980 3	0.885 98396 4	23.46 99236 6	1.172 32350 3	21.65 50960 7	15.43 53599 5	0.868 16456 9	23.72 96991 3	0.541 56148 1	0.334 94386 3
1983	Chino ok_1	0.834 60383 6	0.607 22325 6	0.506 79085 9	0.081 58841 1	122.7 9	129.4	135.1 2	154.1 2	18.32 91777 6	26.03 36806 9	13.12 77809 1	221.4 14385 1	0.963 95878 7	18.84 57675 7	8.765 82799 9	14.49 13514	11.44 15317 5	103.0 93200 7	0.963 22861 9	17.11 75678 3	6.976 51592 6	23.93 79864 5	13.86 72382	280.7 61118 6	0.946 54686 3	285.9 48242 2	0.858 93601 1	0.674 29596 1	0.875 03571 6	5.047 92217 2	25.35 79797 6	14.02 88707 7	0.941 94732 9	21.63 24436 2	1.882 13301 5	21.38 31149 3	14.19 48671 3	0.926 68167 8	22.32 67250 1	1.470 17998 2	17.27 33491 2	14.32 25956 3	0.916 52092 3	22.97 56403 2	0.574 75366 1	0.431 30815 4			
1984	Chino ok_1	0.837 58171 9	0.583 62424	0.488 83299	0.149 42951 5	129.1 2	135.5 9	140.7 9	149.9 6	15.83 39349 3	29.28 07274 4	13.73 40126 7	230.2 79933	0.955 95358	19.45 50378	6.977 94692	17.45 90292	12.26 45759	123.7 05212	0.942 34746	18.38 20884	6.549 85116	26.05 71669	14.28 99996	281.7 99031	0.945 26927	19.54 80847	289.5 88989	0.748 27154	0.251 72845	0.657 34584	0.818 37335	0.870 53890	4.720 31568	27.71 68609	14.45 30782	0.940 43167	21.60 32932	1.724 13347	23.27 32592	14.65 35965	0.922 21075	22.38 90349	1.343 58342	18.88 71609	14.82 50989	0.908 61415	23.04 15468	0.563 39166	0.388 12755 2
1985	Chino ok_1	0.847 46867 1	0.718 08892 8	0.608 55787	0.010 99887 2	110.9 3	121.3 8	128.9 6	133.8 1	21.85 43810 1	21.78 35228 5	11.18 85365	178.9 08432	0.967 12939 7	17.45 75717 4	10.72 60502	11.71 85639	9.675 05035	97.02 05200	0.967 24078	16.88 75858	8.042 99223	20.30 56667	11.75 79735	223.0 12179	0.950 60151	17.22 92411	228.2 75482	0.983 29453	0.016 70546	0.767 77323	0.864 81739	0.908 75884	5.796 16892	21.47 61678	11.96 52397	0.948 82910	19.36 32858	2.225 03539	18.16 94450	12.17 14276	0.934 20056	20.24 12771	1.742 76341	14.62 71954	12.31 13184	0.928 16909	21.42 59395	0.667 03032	0.507 99395
1986	Chino ok_1	0.814 58533 6	0.588 23575 6	0.479 16822 1	0.065 06880 9	123.4 5	128.8 7	132.7	153.9 1	19.29 49382 4	24.26 12546 8	13.00 85392	206.3 03151	0.965 32805	18.48 31652	9.150 35552	14.00 72742	11.50 30605	103.0 88612	0.966 16877	17.50 30319	7.305 93267	22.39 86370	13.60 13625	259.0 15324	0.947 29168	18.49 96980	260.5 98663	0.881 33642	0.118 66358	0.674 89413	0.825 14734	0.875 92383	5.329 10421	23.59 29301	13.70 05945	0.943 48564	20.77 51110	2.027 92593	19.90 28981	13.88 87259	0.928 60519	21.55 44751	1.587 19843	16.01 93812	14.05 95760	0.920 33579	22.39 11171	0.542 25078	0.408 49865
1987	Chino ok_1	0.762 96765 3	0.529 20461 6	0.403 76600 4	0.037 83782	119.1 7	127.1 5	132.4 6	141.6 9	19.22 41180 5	24.79 66339 3	13.83 24053	200.8 17979	0.969 59659	17.39 14610	9.455 52340	12.83 39739	12.53 93692	63.00 44174	0.972 79456	13.71 74137	7.058 57799	23.55 7742	14.37 06601	275.3 46928	0.951 73007	18.76 24494	282.6 92810	0.919 70919	0.080 29080	0.617 69399	0.803 89664	0.859 17271	5.180 26540	24.81 15379	14.45 25133	0.947 27499	21.76 51096	1.934 67343	20.80 77177	14.56 09143	0.928 46854	22.45 51474	1.511 17998	16.80 97862	0.914 73266	22.94 27362	0.489 93274	0.308 66383	
1988	Chino ok_1	0.818 85710 8	0.712 89806 9	0.583 76165	0.014 67497 1	109.4 1	121.3 1	128.8 8	131.4 2	24.41 51510 9	20.67 14011 6	11.09 65538	152.1 64739	0.963 71151	15.41 45434	13.16 52340	9.112 93470	9.544 90661	58.24 85824	0.964 56692	13.29 61118	8.156 28791	19.93 75423	11.71 48842	200.6 94061	0.944 85480	15.81 66342	208.1 94061	0.977 26418	0.022 73581	0.766 87607	0.865 29889	0.909 22631	5.887 44903	21.06 24676	11.88 16989	0.946 23900	18.15 79493	2.266 89950	17.84 24554	12.06 84715	0.931 96574	19.23 85412	1.775 17820	14.36 34679	12.21 14939	0.927 67074	20.59 02977	0.646 39120	0.489 98960
1989	Chino ok_1	0.805 82800 2	0.514 17783	0.414 33889	0.048 25255	142.8	150.6 1	154.7 2	148.8 2	17.06 28307 2	28.61 85108	14.13 76833	191.0 84053	0.971 42014	17.61 78429	8.313 86360	14.62 69857	12.41 58557	77.39 14947	0.975 99480	15.46 92060	6.495 85140	26.22 62806	14.96 53735	252.1 22589	0.953 31818	18.17 94238	257.9 12506	0.898 61882	0.101 38117	0.593 26489	0.788 96042	0.846 77816	4.691 97345	27.87 11047	15.10 52505	0.950 48317	20.85 96122	1.729 28128	23.24 09499	15.19 34986	0.935 36599	21.65 04726	1.349 55406	18.80 39769	15.25 90928	0.927 11901	22.36 08627	0.529 30682	0.300 70394
1990	Chino ok_1	0.739 75830 4	0.346 26640 3																																															

Columbia River System Operations Environmental Impact Statement
Appendix E: Fish, Aquatic Macroinvertebrates, and Aquatic Habitat

Year	Species	InRivSurvSNK	InRivSurvLCol	InRivSurv	ProportionTransported	MedDayLGR	MedDayConfl	MedDayBONinriv	MedDayBONtrans	meanTravelTime	meanMigRate	meanTemp	meanFlow	meanFSpill	meanGas	SNKTravelTime	SNKMigRate	SNKTemp	SNKFlow	SNKFSpill	SNKGas	LCTravelTime	LCMigRate	LCTemp	LCFlow	LCFSpill	LCGas	BonFlow	propBONinriv	propBONtrans	JDAInRivSurv	DeschInRivSurv	BONInRivSurv	JDATime	JDAMigRate	JDATemp	JDAFSpill	JDAGas	DESTime	DESMigRate	DESTemp	DEFSpill	DESGas	BONTTime	BONMigRate	BONTemp	BONFSpill	BONGas	monte_q975	monte_q025
1995	Chino ok_1	0.835 54450 5	0.622 42125 4	0.520 06065 8	0.052 89307	128.3 9	134.7 7	140.2 4	144.6 3	18.66 72317 2	25.76 60613 9	12.96 48554 7	205.5 11996 1	0.967 20558	18.32 47456 2	9.119 32181 6	13.87 93492	11.40 40424 3	96.88 71139 5	0.971 00951 7	16.81 64653 8	6.938 83471 2	24.03 73044 7	13.66 32262 9	260.5 38678 5	0.947 63846 2	18.55 14641 6	269.9 09057 6	0.908 03791	0.091 96209	0.689 38482 4	0.833 71500 2	0.883 52560 3	5.016 0449	25.46 69962 7	13.80 23876	0.944 29365 4	20.89 08119 2	1.874 78245 8	21.45 18407 2	13.93 43258 5	0.926 51488 4	21.66 50301 6	1.463 54796	17.35 05760 4	14.04 12893 3	0.915 08314	22.42 49115	0.583 50068 8	0.451 27945 6
1996	Chino ok_1	0.799 52433 8	0.523 84408 6	0.418 82609 6	0.167 10433 6	140.9 1	143.6 7	145.6 3	152.3 9	15.09 45691 9	30.65 70457 9	14.56 52866 4	262.4 73653	0.946 49981 6	19.88 84322 3	6.709 90804 6	18.40 13712 2	13.66 24794 9	121.5 46131 9	0.938 17342 5	17.99 16599 3	6.119 23087 4	27.98 63577 9	14.93 33965 2	333.5 0.926 1	20.38 10980 6	342.8 36425 8	0.693 27009 2	0.306 72990 8	0.612 62445 3	0.804 64269 1	0.860 84873 8	4.392 32433 6	29.82 27193 9	15.01 92457 2	0.917 76913 4	22.90 88008 9	1.598 00884 9	25.07 60136 8	15.10 50090 8	0.896 74111 2	23.13 73036 7	1.243 71913 8	20.40 36703 5	15.19 62046 6	0.877 99793 5	23.60 07261 3	0.498 28799 6	0.325 28783 8	
1997	Chino ok_1	0.837 17588	0.552 93226 9	0.462 64842 3	0.260 64842 3	133.3 2	135.7 2	138.7 3	143.5	14.06 47067 3	31.70 06126 1	14.07 90446 8	363.0 41204 2	0.902 43582 2	22.41 37524 2	5.931 19487 2	20.80 07354 7	12.79 93507 4	159.4 93624 9	0.886 24249 7	19.74 97764 6	5.737 54604 2	29.94 85107 3	14.68 68244 8	468.0 00549 3	0.867 14837	23.13 02715 9	478.4 10980 2	0.583 55689 9	0.416 44310 1	0.649 53837 8	0.830 25795 7	0.883 49490 2	4.055 58843 9	32.07 67956 8	14.75 72475 4	0.851 87639 4	25.45 66230 8	1.427 66206	28.05 38080 9	14.82 00197 2	0.861 56121 9	25.24 19719 7	1.109 95505 8	22.88 86579 5	14.90 80753 3	0.852 92720 8	25.35 50100 3	0.538 77800 6	0.384 17126 6
1998	Chino ok_1	0.848 01997 2	0.643 00293 4	0.545 27933	0.098 31365 3	116.5 2	125.1	131.3 1	131.9 3	19.54 66484 8	24.71 60283 6	12.68 5087	255.9 83872 5	0.948 56589 6	19.11 45846 5	9.673 71539 8	13.54 82394	10.66 56797 4	105.7 21310 2	0.953 61477 1	16.62 81990 1	7.025 23963 9	23.90 01825 9	13.56 17680 5	331.9 41970 8	0.918 64187 5	19.85 12931 7	345.1 56738 3	0.842 13899 8	0.157 86100 5	0.704 57039 4	0.838 71369 6	0.888 04592 7	5.056 46281 7	25.38 13484 2	13.75 14240 3	0.909 45998 4	22.32 28794 2	1.862 85009 9	21.57 34968 3	13.96 22910 8	0.885 79672 6	22.83 15124 5	1.453 34433 8	17.47 04667 5	14.11 08012 2	0.864 58012 5	23.30 55763 2	0.615 55309	0.452 32195 3
1999	Chino ok_1	0.835 95861 7	0.629 23541 5	0.526 01476 9	0.037 32659 9	121.7 3	128.8 4	135.4 7	132.6 6	19.08 39444	24.61 52184 4	12.80 12322	203.8 33747 3	0.967 95441 4	18.22 47334 2	9.058 35874 4	13.66 79471 8	11.05 65624 2	95.06 22360	0.974 03705 1	16.93 82232 7	7.280 03823 8	22.73 48495 1	13.57 56454 5	260.2 86304 5	0.946 91546 6	18.34 83382 9	267.9 91546 6	0.935 72367 7	0.064 27632 3	0.691 08463 5	0.831 77161 8	0.881 68892 1	5.305 83655 8	23.99 20136 8	13.73 80014 4	0.942 41428 4	20.77 89753	1.987 54864 9	20.25 86328	13.89 64589 4	0.925 38082 6	21.44 07564 8	1.552 57159 5	16.37 00833 5	14.01 09539	0.914 82839	22.32 85923	0.604 68613 7	0.428 12446 5
2000	Chino ok_1	0.785 75568 2	0.435 89752 2	0.342 50895 5	0.036 26953	131.8 7	138.9 5	141.1 2	139.9 9	16.84 29284 9	27.75 66957 8	14.44 08525 1	187.6 28549 8	0.973 46416 1	17.73 68352 1	7.761 79000 7	15.65 89217	13.14 01454 9	85.19 15039 1	0.979 89699 8	16.25 10889	6.705 69443	24.80 76241 2	15.12 24861 1	240.9 91546 3	0.954 83574 3	17.91 81685 4	250.0 07461 5	0.909 09768 2	0.090 90231 8	0.534 09009	0.771 32076 4	0.833 42485	4.935 07730 2	26.10 10832	15.16 73852 9	0.951 84941 3	20.38 95576 5	1.840 41350 3	21.82 31321 8	15.15 55544 5	0.937 13345	21.19 46207 7	1.435 09163	17.69 12217	15.20 32141 7	0.930 05824 1	22.19 04306	0.442 80646	0.236 58617 2
2001	Chino ok_1	0.808 74910 3	0.618 19955 9	0.499 96833 9	0.018 37877 4	110.8 5	123.2 7	130.5 3	130.1	24.17 87552 2	21.25 67835 2	12.38 91788 7	140.1 87287 6	0.950 58252 6	14.52 05489 6	13.17 88998	9.406 12888 3	10.09 44908 1	49.65 49293 5	0.943 20372 3	11.80 59499 7	8.040 19673 9	20.12 75998 3	13.40 74147 5	184.2 09246 3	0.932 02281	15.24 66165 2	196.2 06115 7	0.967 22251 1	0.032 77748 9	0.679 81234 6	0.819 56837 6	0.870 60530 6	5.860 11298 7	21.17 39957 1	13.61 21658 3	0.939 11541 7	17.31 00788 1	2.250 50973	17.95 05325 9	13.84 69187 4	0.924 42967 5	18.29 51583 9	1.760 62011	14.47 92196 4	14.00 41098 6	0.921 26697 3	19.72 07765 6	0.586 86181 6	0.387 30675 1
2002	Chino ok_1	0.819 93088	0.629 73285 6	0.516 33741 5	0.040 36615 2	121.0 5	130.5 4	136.8 1	133.6	19.92 85066 4	24.69 17463 4	12.79 33468 1	178.6 73415 6	0.966 10831 4	16.54 95390	10.11 19138	12.04 01593 8	11.04 35201 6	70.19 27841 2	0.972 34345 7	14.49 44829 9	7.226 08007 5	22.88 93617 4	13.49 95468 5	233.9 09078	0.943 96663 7	16.97 12910	243.6 93206 8	0.930 19841 5	0.069 80158 5	0.691 01899	0.828 71219 6	0.878 49325 2	5.244 70581 3	24.18 93374	13.69 51158 5	0.940 87467 2	19.41 43886 6	1.971 93436 3	20.39 54522 8	13.91 23729 6	0.924 00586 6	20.25 75664 5	1.538 85377 9	16.51 39279 9	14.07 25593 6	0.915 1555	21.39 31026 5	0.594 25870 3	0.423 60617 5
2003	Chino ok_1	0.815 20534 7	0.624 08742 7	0.508 75940 8	0.074 63199	131.0 9	139.1 7	145.6 5	148.7	17.83 21766 7	27.51 72825 9	13.23 98278 4	219.3 08003	0.961 17301 5	17.95 74448 7	8.857 72504 7	13.97 02448 3	11.82 42736 8	83.26 60125 2	0.967 64445 3	15.41 99512 5	6.594 82642 3	25.69 56182 9	13.89 63082 6	282.6 97654	0.936 36658 8	18.51 48302 7	305.1 58660 9	0.872 65176 2	0.127 34823 3	0.693 48007	0.837 53137 3	0.887 42842 9	4.741 73339 5	27.32 99314	14.02 13905	0.930 69695 2	21.08 34964	1.730 17930	23.12 56734	14.13 00239	0.911 19410	21.95 65073	1.344 67046	18.87 18816	14.21 57702	0.897 33919	22.83 12263	0.579 60967	0.423 43023
2004	Chino ok_1	0.824 48273 9	0.655 33691 8	0.540 31397 7	0.010 62152 6	107.5	120.8 7	128.0 3	130.7 5	24.16 01334 5	20.92 33436 3	11.92 11594	171.5 37910 7	0.969 29871 2	16.31 72785 2	13.04 35797 3	9.702 80371 2	9.653 79524 2	63.05 86311 3	0.970 48648 6	13.56 15881	7.982 07074 4	20.30 35895 9	12.84 39067 2	223.1 47234 6	0.952 95856 4	16.79 12190 8	245.8 91250 6	0.982 15286 9	0.017 84713 1	0.712 98199 8	0.834 26123 6	0.882 37960 9	5.809 01175 7	21.37 55529 3	13.05 71092 6	0.952 84527 5	19.25 94522 5	2.220 56016 3	18.14 87856 7	13.34 42389 2	0.940 95450 6	20.53 59350 8	1.733 85483	14.69 51670 2	13.54 56876 8	0.938 62161	21.98 22111 1	0.622 11107 4	0.427 34635 7
2005	Chino ok_1	0.799 02575 4	0.543 58880 8	0.434 34145 7	0.039 32093 4	124.0 2	132.0 1	137.1 2	136.4 8	18.87 06147 6	25.46 08746 1	12.08 05958 1	185.0 71867 3	0.968 25010 4	17.06 66371 8	9.228 91649 6	13.56 75091 8	12.49 97261	77.07 36801 1	0.969 61658	14.60 08012 8	7.046 22008 7	23.45 87294 2	14.54 05770 9	240.6 89987 2	0.951 23682	17.77 27704	249.1 99569 7	0.920 53300	0.079 46699	0.622 62422	0.798 23815	0.853 62588 8	5.170 20692 7	24.68 84846 6	14.66 41065	0.949 14704 6	20.18 73710 6	1.938 30152	20.75 33020	14.80 48804	0.933 38280	21.07 74459	0.938 07883	16.79 05255	14.90 74711	0.924 81198	22.03 88336	0.525 64272	0.328 26904
2006	Chino ok_1	0.859 99311 7	0.699 79649 5	0.601 82016 9	0.094 55563 2	122.1	129.0 8	135.6 9	129.0 1	17.49 51802 3	26.32 20287 3	12.08 15555 7	250.1 00484 6	0.958 62196	20.07 11977	7.827 21333	16.10 90846	10.70 61189	126.5 51535	0.957 29302	18.87 42683	6.974 51025	24.23 56957	12.64 88466 3	307.3 78189	0.939 04067	20.25 91424	322.4 17999	0.859 19801	0.140 80198	0.754 76072	0.863 24629	0.908 69954	4.999 27967	25.79 47428	12.82 38658	0.931 49402	22.46 42189	1.833 38367	21.87 69630	12.97 46542	0.912 06181	22.94 36817	1.427 86669	17.77 92061	13.05 97500	0.896 75509	23.43 06364	0.682 83489	0.505 57384
2007	Chino ok_1	0.800 12690 7	0.567 17035	0.453 80826	0.029 80813	122.2 6	129.8	135.0 2	133.4 5	19.31 53772 5	24.83 70855	13.67 13444	193.2 76809	0.970 83107	17.35 31904	9.543 68715	13.04 92083	12.22 51293	73.52 05490	0.975 41779	14.61 86500	7.080 54115	23.30 66839	14.28 02599	254.6 7571	0.952 42450	18.16 50372	264.7 84240	0.941 75158	0.058 24841	0.640 54503	0.807 52224	0.861 49255	5.189 95728	24.53															

5 **Table 4-4. Snake River MO3 Spring Chinook Raw Data**

Year	Species	InRivSurvSNK	InRivSurvLCol	InRivSurv	MedDayLGR	MedDayConfl	MedDayBON	SAR	TotalReturn	meanGas	SNKTravelTime	SNKMigRate	SNKTemp	SNKFlow	SNKFSpill	SNKGas	LCTravelTime	LCMigRate	LCTemp	LCFlow	LCFSpill	LCGas	BonFlow	monte_q975	monte_q025
SCN MO3-RESSIM-GRNIMN																									
1929	Chinook_1	0.91951197 3	0.63804893 3	0.58669363 4	126.83	130.81	138.15	0.01797422 9	10537.4319	9.74307852 1	7.37025114 9	12.3466969 7	11.4531156 5	55.7320259 1	0.93064132 9	0.77368741	7.87596099 8	20.8283674 8	13.1981889 4	154.738746 6	0.89944540 5	14.2568874 4	169.606124 9	0.70360095 9	0.44662648 9
1930	Chinook_1	0.85109864 3	0.53745112 3	0.45742392	116.72	123.3	129.65	0.01934874 5	8841.23470 5	9.89505038 9	14.5852059 3	7.93114934 3	11.2022548 7	64.0746810 9	0.95738836 5	0.82858772 3	8.09912806 7	19.7008283 3	13.8770481 7	159.209579 5	0.91969931 1	14.5823961 9	164.681304 9	0.58077086 2	0.3328846
1931	Chinook_1	0.84325487 3	0.53585922 3	0.45186590 1	116.03	122.97	129.98	0.01964733 5	8868.88840 5	9.90719825 9	15.3932027 8	7.43315911 5	11.1062358 9	44.9314361 6	0.93623480 8	0.80398607 3	8.16307189 3	19.6218648 5	13.9646094 6	157.775878 9	0.90966674 7	14.5499431 3	169.608367 9	0.57317600 3	0.34417532 8
1932	Chinook_1	0.90045839 9	0.70831990 2	0.63781260 5	122.07	126.2	133.14	0.01927782	12286.0075 5	12.138401	9.40351716 4	10.5064743 3	10.7130851 7	86.2285491 9	0.98334198	1.15374555 6	7.16758775 7	23.7248226 3	12.6672638 3	298.346466 1	0.86127863 3	17.8426383 3	318.084564 2	0.72909397 8	0.50342299 3
1933	Chinook_1	0.92223790 1	0.62228704 9	0.57389670 2	132.93	136.91	143.86	0.01608342 5	9220.06130 7	11.3999949 5	7.18113213	12.4242717 1	11.6509302 1	57.0950935 4	0.98046021 5	1.09603853 2	6.95764536 4	24.1510606 9	13.8488736 2	225.513148 9	0.90334251 5	17.0476721 1	238.642639 2	0.69313111 2	0.43821899 7
1934	Chinook_1	0.88878073 1	0.54387928 7	0.48338943 1	120.59	125.02	130.57	0.01943087 1	9383.07250 8	12.0294033 1	10.5990571 1	9.85541333 7	12.3594221 1	73.9221832 3	0.96766001 5	1.20884542 5	7.13028064 4	23.3993467 2	14.3188770 6	304.667287 2	0.84752363	17.9106698	310.167541 5	0.59410766 3	0.38058646 6
1935	Chinook_1	0.92682257 9	0.58539545 6	0.54255772 6	128.29	131.9	139.08	0.01729958 2	9376.86858 7	11.2981762 5	6.70103823 4	13.3562266 5	12.0040674 2	63.6414009 1	0.97939270 7	1.07433271 4	7.03005900 2	23.7220632 7	14.1815136 3	227.601048 8	0.89979320 8	16.8604140 3	240.029342 7	0.66307062 6	0.40471957 6
1936	Chinook_1	0.90943288 5	0.69020588 1	0.62769592 5	120.81	124.91	131.73	0.01947749 3	12214.4047 9	12.0762727 3	8.38457281 1	11.8978514 8	10.6121681 2	121.452291 9	0.97902047 6	1.18672056 2	7.23342457 4	23.4538797 8	12.2757956 2	297.806493 1	0.85792724 3	17.8799624 4	311.255554 2	0.71696910 5	0.52100162 5
1937	Chinook_1	0.90236196	0.63993745	0.57745521 1	126.51	130.33	137.16	0.01818074 4	10487.1660 7	10.4601167 6	9.24587478 5	10.3160491 7	10.9565120 7	58.3563232 4	0.95641621 4	0.87134494 8	7.65451563 9	21.4980137 7	13.3516076 4	182.973734 5	0.91042129 2	15.4879593 1	196.863845 8	0.69215532 1	0.43582029 9
1938	Chinook_1	0.93179389 5	0.60225203 6	0.56117477	131.46	135.02	139.34	0.01642837 7	9210.64289 9	11.9874011 1	6.19638021 3	14.5326636 5	11.7165750 5	108.177404 8	0.97046555 3	1.17467603 7	6.69875830 4	25.3989870 9	14.0027354 6	289.179570 5	0.85878296 7	17.7504723 9	296.885345 5	0.66703118 5	0.45226687 3
1939	Chinook_1	0.90655867 1	0.69439963 6	0.62951401 1	121.7	125.5	132.48	0.01929629 2	12135.8402 9	11.3939533 6	8.64353823 7	11.3746131 7	10.6341621 4	91.4603118 9	0.98597080 7	1.07283926	7.52269357 4	22.0804701 1	12.1190954 8	235.969810 5	0.89914451 3	17.0999843 3	241.628662 1	0.70779798 9	0.51259677 1
1940	Chinook_1	0.79803357 1	0.61293936 6	0.48914619 1	110.48	120.92	127.55	0.01962148 6	9587.34405 1	11.2006263 4	20.7824112 6	5.98227420 4	10.2967475 9	80.4159851 1	0.97933387 8	0.98790674 2	7.89070075 8	20.5121318 5	13.1506015 5	222.709592 2	0.90441404 8	16.7723937 3	232.951995 8	0.60023349 1	0.36949211 4
1941	Chinook_1	0.92347447 5	0.46136831 1	0.42606185 9	134.74	138.12	139.2	0.01557347 5	6628.89471 9	10.6614911 2	6.98196951 3	12.9816041 2	13.6569362 6	59.1468177 8	0.96629347 8	0.93775863 6	7.21792952	22.6438598 1	15.1457451 2	190.296770 7	0.91176753 2	15.8943824 8	197.497192 4	0.56784724 7	0.29798259 4
1942	Chinook_1	0.91977443 1	0.65672771 6	0.60404136 2	137.6	141.32	147.09	0.01433378 3	8648.69308	11.2213280 5	7.52163228 4	12.3326107 5	11.4259977 3	86.1408096 3	0.96919592 6	0.99987125 4	6.78798627 9	25.0953951 1	13.4601082 8	245.951383	0.87905446 7	16.5835750 9	257.348053	0.70601766 4	0.49697449 2
1943	Chinook_1	0.89899595 2	0.65828960 8	0.59179969 3	126.46	129.96	135.89	0.01841602 7	10887.5565 6	11.6169096 1	9.70758617 7	10.2766920 5	10.7512512 2	110.091339 1	0.97428017 9	1.14878664	7.29464828 2	22.8769670 1	13.1995727 2	258.110392 3	0.88045969 6	17.3516902 9	262.399444 6	0.69628862 5	0.46670702 5
1944	Chinook_1	0.92595877 9	0.59129280 2	0.54751276 1	132.37	136.03	143.18	0.01595636 2	8728.50221 2	10.1929352 6	6.84308819 5	13.1567668 6	11.7162202 8	65.9520416 3	0.95910004 4	0.89084110 3	7.36213329 4	22.3766323	13.9822613 4	169.021110 5	0.91854564 3	15.1238465 3	174.649673 5	0.67369809 1	0.39607881 6
1945	Chinook_1	0.90604837 3	0.65755437 3	0.59577607	122.69	126.62	133.46	0.01883207 1	11209.2886 8	11.1265016 6	8.75009042 8	11.3775465 5	11.0907497 4	78.4650528	0.96684432	0.92085351 9	7.41672853 4	22.4637772 4	13.1148940 7	232.592056 3	0.89017917 7	16.5286544 2	248.492553 7	0.69677004 8	0.48264376 3
1946	Chinook_1	0.88592046 6	0.71673001 8	0.63496579 2	118.14	122.54	129.76	0.01990561 6	12628.9080 9	12.3910016 3	10.8431506 8	10.0675307 3	10.3885433 2	118.772390 7	0.96227890 3	1.09720764 2	7.33188948 8	23.344818	12.4070525 2	333.629125	0.83496078 8	18.0575261 1	349.097137 5	0.72511766 7	0.51390775 4
1947	Chinook_1	0.88921373 6	0.58966778	0.52434068 9	118.47	123.13	129.7	0.01971693 1	10329.1473 4	12.3495484 4	10.4396191 5	10.5165081	11.2644084 9	101.792463 7	0.97730661 6	1.12215929	7.15502580 3	23.5736384 7	14.0437782 6	321.320688 9	0.84590356 5	17.9711931 5	343.041992 2	0.63581780 2	0.39263056 2
1948	Chinook_1	0.94160511 2	0.60993903 4	0.57432171 3	134.75	137.96	141.43	0.01584427 2	9091.68820 1	14.9434089 7	5.25417260 1	16.8407571 7	12.2574214 9	139.060006 7	0.97316820 6	1.38611640 9	5.87759989 5	30.0873636 7	14.1774738 6	426.889124 6	0.83902421 6	22.0888347 6	447.748138 4	0.66436330 1	0.46494873 8
1949	Chinook_1	0.94200037 2	0.55940055 3	0.52695552 9	127.72	130.85	136.59	0.01753715 8	9234.51550 6	12.9494510 4	5.19831103 1	16.8757010 9	12.3896900 2	120.516464 2	0.96729896 1	1.21154499 1	6.43293333 8	26.9401180 5	14.5641522 4	348.175048 8	0.82865708 1	18.4836802 5	375.075683 6	0.65484770 7	0.39268251 4
1950	Chinook_1	0.92857657 7	0.67626612 2	0.62796488 1	133.92	137.07	143.16	0.01642910 5	10306.0422 1	11.7516859 3	6.58214217 4	13.7575434 5	11.3740163 8	91.4781906 1	0.97971851 8	1.11813993 5	6.66097728 9	25.7919825 1	13.3158965 1	277.308784 5	0.86921				

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Appendix E: Fish, Aquatic Macroinvertebrates, and Aquatic Habitat

Year	Species	InRivSurvSNK	InRivSurvLCol	InRivSurv	MedDayLGR	MedDayConfl	MedDayBON	SAR	TotalReturn	meanGas	SNKTravelTime	SNKMigRate	SNKTemp	SNKFlow	SNKFSpill	SNKGas	LCTravelTime	LCMigRate	LCTemp	LCFlow	LCFSpill	LCGas	BonFlow	monte_q975	monte_q025
1953	Chinook_1	0.911897114	0.654167354	0.596533323	135.46	139.19	145.99	0.014705731	8762.806923	11.86233888	8.310674816	11.52920858	11.32862549	88.83659515	0.975392222	1.084403229	6.63272243	25.82464734	13.59121561	281.8044357	0.866138905	17.44076316	297.3147278	0.692360508	0.494086118
1954	Chinook_1	0.922574265	0.675024034	0.622759802	141.28	144.28	148.99	0.01373757	8546.658305	12.17390398	7.236205108	12.89355536	11.42132835	98.67952271	0.9631935	1.124915028	6.304457039	27.66953762	13.45789117	314.7511037	0.840987474	17.81955544	326.6013794	0.713830504	0.512664237
1955	Chinook_1	0.929906421	0.648177994	0.602744879	136.84	140.36	146.38	0.014973614	9015.730534	11.42092211	6.429598212	13.9405412	11.37709293	88.4086853	0.97803303	1.05502367	6.743965469	25.17353664	13.63694318	245.5205256	0.888633341	16.98496771	256.5126343	0.712570721	0.481173701
1956	Chinook_1	0.906133693	0.697463847	0.631995491	122.85	126.91	132.9	0.018123427	11442.39662	13.25276559	8.808096752	11.58526579	10.76030407	138.3050171	0.966805625	1.306995201	6.79120408	25.43286515	12.57335504	364.3822327	0.828549753	19.43841267	375.5515747	0.703769236	0.536374071
1957	Chinook_1	0.893339143	0.678638308	0.606254165	124.48	128.66	133.35	0.017154189	10388.49071	13.55484813	10.19157058	10.46273715	11.20806351	125.598822	0.966902637	1.135985565	6.524390794	26.77976734	12.78352737	385.42217	0.816754232	19.31088352	410.7419739	0.666248665	0.515012875
1958	Chinook_1	0.939178492	0.655226534	0.615374662	129.05	132.12	137.04	0.016911182	10399.38282	12.88507894	5.45395501	16.15490511	11.60430222	121.9439301	0.970582187	1.154717731	6.365319476	27.5624409	13.44754855	354.4240316	0.827302625	18.6006004	375.657074	0.704563601	0.506928404
1959	Chinook_1	0.927685893	0.586954387	0.544509305	137.88	141.2	146.27	0.01460657	7946.030817	12.13008451	6.619180784	13.72166113	12.13734379	83.29364471	0.979535532	1.203538513	6.367312796	27.06465894	14.44059674	297.7823537	0.857791076	17.94772418	308.4461365	0.657048202	0.426673762
1960	Chinook_1	0.925295688	0.62760858	0.580723512	136.05	139.16	144.53	0.01558199	9039.469196	11.72261773	6.923245594	13.07176348	11.39951496	84.55063477	0.979423833	1.160501385	6.670934319	25.50935491	13.9031024	261.7273966	0.880183806	17.46096881	271.8879395	0.695524332	0.454909777
1961	Chinook_1	0.895946799	0.607677799	0.544446979	123.41	127.49	134.77	0.017865012	9717.220352	11.73511944	9.849876508	9.984995959	11.42545509	62.3269577	0.976623905	1.092525959	7.117362283	23.48153871	13.94940964	262.4614207	0.880164305	17.33185228	273.1824036	0.637186369	0.437397764
1962	Chinook_1	0.912245832	0.672306129	0.613308464	122.02	126.07	133	0.019032317	11660.41318	11.57837319	8.143001921	11.66511708	10.84412975	86.22023621	0.985022473	1.149559116	7.351481594	22.75646516	12.99183957	251.0541738	0.886989931	17.33767239	256.1709595	0.718465039	0.468362644
1963	Chinook_1	0.896580765	0.574516687	0.515100611	122.97	126.92	133.87	0.018193594	9361.208348	10.95920784	9.807044894	10.38159926	11.62855854	75.14878693	0.967859614	0.95895319	7.416600794	22.18532549	14.13773648	217.6136703	0.899022082	16.28691419	226.829834	0.630147911	0.407795359
1964	Chinook_1	0.936426246	0.609347576	0.570609063	135.29	138.57	144.41	0.015312177	8728.04168	11.86279212	5.783794835	15.35983009	11.67931919	101.2356598	0.974354732	1.105082798	6.352858052	27.30035613	14.36171373	291.8307393	0.859381417	17.46334791	305.9496155	0.711355688	0.419394153
1965	Chinook_1	0.944744319	0.497828892	0.470321017	146.36	149.43	148.21	0.01300828	6112.78482	12.33477572	4.968125656	17.73091952	13.62976742	135.2108521	0.958056331	1.181816101	6.149210326	28.29269537	14.7521855	325.539327	0.822197835	17.9959712	332.7698669	0.572586705	0.38138443
1966	Chinook_1	0.871501107	0.670544651	0.584380406	118.74	124.57	131.52	0.01965926	11476.82599	10.93972591	12.25987186	8.531453612	10.66532478	58.73991699	0.965168226	0.915812969	7.756333426	21.3169436	12.3492926	219.4164098	0.893023685	16.20354605	236.4047089	0.675214291	0.465105698
1967	Chinook_1	0.910851918	0.710139328	0.646831768	128.01	132.01	138.8	0.017566125	11351.44096	11.53518966	8.291448459	11.2603182	10.869688231	62.52724228	0.969860578	0.999725628	7.016275726	24.29462028	12.44458246	260.0910467	0.877389411	16.9295942	276.5617371	0.735702393	0.526233183
1968	Chinook_1	0.937565747	0.408110945	0.382630843	141.54	144.55	145.9	0.014106951	5393.086405	10.9969323	5.615753599	15.62775173	14.79137745	71.10960236	0.956375873	1.006910706	6.663950138	24.89832647	15.67375008	232.7833023	0.874175608	16.19824251	243.932724	0.552925443	0.253497621
1969	Chinook_1	0.902436718	0.623429557	0.562605723	121.58	125.47	132.36	0.018880455	10611.90831	12.69261166	9.202322118	11.12789181	11.0805151	113.386087	0.973386145	1.221264553	6.89298138	24.73873978	13.96745682	334.0370382	0.837221195	18.42740568	346.5262451	0.668496946	0.440468058
1970	Chinook_1	0.913740141	0.671385961	0.613472302	130.14	133.7	139.87	0.015975565	9791.469898	11.25051144	8.024923407	12.04062043	11.23813343	94.77518463	0.955091608	0.925585365	6.980564818	24.2949341	13.01663303	252.3484421	0.870297223	16.51757256	262.0503235	0.692861075	0.52616219
1971	Chinook_1	0.949142567	0.618053417	0.586620803	139.54	142.58	145.84	0.014461049	8476.242527	13.93855844	4.538954891	18.99980906	12.47486534	153.8974213	0.958529794	1.268523216	5.647075713	32.03135534	14.2178305	423.0275625	0.784229567	19.98452075	427.6967773	0.71490171	0.481277618
1972	Chinook_1	0.927067046	0.611353837	0.566765996	127.65	130.88	136.87	0.016675407	9442.89908	13.85228263	6.670724474	14.17220295	11.90922947	123.3926147	0.976343942	1.308959484	6.236855924	27.83003917	14.30636215	387.0840302	0.830152889	20.2781353	393.138031	0.667285026	0.453390758
1973	Chinook_1	0.88885457	0.548733634	0.487744398	126.22	130.8	137.19	0.016088301	7838.703164	10.21624395	10.62034435	9.602387417	11.83526173	54.35994339	0.939919651	0.9034132	7.553182669	21.6597862	14.14437946	176.7596181	0.89384528	15.08821217	186.2350159	0.568599073	0.386582683
1974	Chinook_1	0.944071447	0.578793798	0.546422698	137.29	140.71	144.88	0.014752441	8054.61513	13.77100512	5.015065014	17.47272012	12.66381779	137.8013763	0.959726834	1.296234417	5.859670542	30.25790181	14.73461119	403.0603333	0.805182864	20.03444783	406.5570984	0.670092468	0.403607966
1975	Chinook_1	0.944490532	0.588835357	0.55614942	147.11	150.56	153.56	0.011210102	6229.503422	12.58894035	4.965929739	17.4883015	12.59099846	127.7710251	0.966871297	1.219190598	5.967390075	29.41899212	14.34786574	334.2131958	0.824848125	18.27005005	342.1758118	0.64579236	0.45877565
1976	Chinook_1	0.921274994	0.723050685	0.666128515	124.38	127.77	134.15	0.018664266	12421.0924	12.87717359	7.257619441	13.23277822	10.7641531	125.5688583	0.973415685	1.18841486	6.727562062	25.94914785	12.51071548	353.3695984	0.825597992	18.57297421	366.9285278	0.756186103	0.560776593
1977	Chinook_1	0.911862878	0.49929769	0.455291029	132.54	136.53	142.24	0.015328032	6971.79978	9.450152022	8.214044109	11.20883701	13.14298668	38.55773315	0.945009112	0.823343754	7.659936383	21.07548437	14.75990661	142.788147	0.909552753	13.8930645	148.3406219	0.583046014	0.327960921

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Appendix E: Fish, Aquatic Macroinvertebrates, and Aquatic Habitat

Year	Species	InRivSurvSNK	InRivSurvLCol	InRivSurv	MedDayLGR	MedDayConfl	MedDayBON	SAR	TotalReturn	meanGas	SNKTravelTime	SNKMigRate	SNKTemp	SNKFlow	SNKFSpill	SNKGas	LCTravelTime	LCMigRate	LCTemp	LCFlow	LCFSpill	LCGas	BonFlow	monte_q975	monte_q025
1978	Chinook_1	0.869989138	0.711901829	0.619346858	118.09	123.08	130.4	0.019198332	11877.21616	11.62720254	12.59326241	8.708083506	10.38503952	94.29417725	0.980024517	1.079886341	7.531386115	22.14946813	12.12932984	267.6116638	0.875553826	17.36266152	274.8617249	0.694180188	0.507525743
1979	Chinook_1	0.875991487	0.721360655	0.631905793	117.9	123.01	130.42	0.019624834	12387.97749	11.15217829	11.85167457	8.9058697	10.31484909	72.77512589	0.970816755	0.879457664	7.709854893	21.66618592	11.94682455	246.8464228	0.882419566	16.55053266	260.4804688	0.726531818	0.482045825
1980	Chinook_1	0.93991957	0.623472754	0.586014243	138.08	141.4	146.98	0.013791463	8075.936106	12.35049663	5.399966009	16.32364847	11.93231602	111.2781433	0.958391964	1.180757141	6.236740068	28.11891937	14.17053032	331.0133921	0.828378717	18.14845864	334.5569153	0.674249405	0.477476145
1981	Chinook_1	0.90019226	0.499438603	0.449590764	132.67	137.11	137.27	0.015536482	6977.808471	11.35453081	9.555914775	10.72119083	13.38823948	85.48097687	0.962440968	1.026318932	6.876742929	24.06418914	14.9556551	257.0675151	0.868207196	16.8061889	262.5525513	0.601491997	0.330339289
1982	Chinook_1	0.943886299	0.522807638	0.493470967	144.71	147.57	148.32	0.012764822	6294.037365	13.03008958	5.041922167	17.50081675	13.46438522	128.2789444	0.967321117	1.258992767	5.86477492	29.96628415	15.16337077	361.0802917	0.816505641	18.92292039	364.9697571	0.644556709	0.364643549
1983	Chinook_1	0.912235771	0.589763998	0.538003816	126.71	130.27	136.36	0.015611425	8391.101238	11.8879994	8.209963776	12.13898892	11.97725792	105.9490158	0.974818206	1.156180573	6.813040696	24.80909892	14.21512699	284.8371277	0.856303455	17.53405825	291.5667419	0.638027451	0.442856938
1984	Chinook_1	0.943318872	0.587335192	0.554044371	130.86	134.21	138.83	0.016094411	8910.027308	11.78775549	5.068282306	17.08178325	12.34697399	123.1325699	0.976578987	1.145207596	6.673440479	25.46470265	14.08726867	275.2105662	0.865318179	17.49943463	281.9351196	0.666289881	0.439044433
1985	Chinook_1	0.870488156	0.705943214	0.614515207	118.04	123.39	130.99	0.019365278	11888.67757	11.23055727	12.45754977	8.730164665	10.10659237	92.3706131	0.979445267	1.055748653	7.819456428	21.07637593	12.12232335	218.0826569	0.907713165	16.88529619	223.8692169	0.695462422	0.490003517
1986	Chinook_1	0.898020396	0.540958789	0.485792026	127.64	131.72	135.4	0.016658896	8084.753116	11.63381423	9.758089416	10.4639178	12.04646282	103.4543228	0.974118423	1.101505375	7.050440215	23.50996958	14.29731242	254.5388565	0.879280984	17.30922624	258.1813354	0.584277663	0.397132418
1987	Chinook_1	0.91485856	0.49971266	0.457166405	121.74	125.63	131.14	0.019493826	8905.648857	11.66559345	7.812431037	12.28298768	13.12041416	63.16126862	0.978138721	1.135641766	7.180689178	23.05160128	14.56090403	268.5461655	0.872782369	17.36440198	276.5710754	0.588271415	0.336076163
1988	Chinook_1	0.850889159	0.691161886	0.588102156	116.74	122.93	130.7	0.019357969	11372.48608	10.31989721	14.60244667	7.532225755	10.2402977	57.27506256	0.968094265	0.881466579	8.142564349	19.95885462	11.96848712	176.5716832	0.919927289	15.31967163	180.3801422	0.683119718	0.460307736
1989	Chinook_1	0.932490043	0.538117312	0.501789035	143.66	147.14	151.76	0.01313327	6585.179631	11.60422438	6.124598064	14.43064719	12.12050991	75.94868774	0.981603098	1.161755466	6.585004777	25.91268739	14.82100232	246.3459167	0.888988088	17.3304135	252.93013	0.655122	0.354336633
1990	Chinook_1	0.937939556	0.399101619	0.374333195	132.3	135.82	139.84	0.017161879	6418.920605	11.09339234	5.571617745	15.53719995	14.07530346	62.48364182	0.977507198	1.135574818	6.974780381	23.48421567	15.71195857	211.1404673	0.908140808	16.64465396	210.0681915	0.588613535	0.249601963
1991	Chinook_1	0.899317841	0.591592275	0.532029488	128.2	132.39	138.96	0.016657544	8853.245697	11.63087967	9.521862343	10.34831985	11.69287987	64.33817596	0.970375407	1.085660934	6.888060369	24.47311891	14.14747016	268.5400517	0.868234247	17.17609088	271.1170349	0.629436896	0.424705098
1992	Chinook_1	0.910411948	0.485355513	0.441873458	124.25	128.27	132.59	0.018980949	8378.460151	10.97966514	8.249876574	11.33125286	13.320401	50.94631577	0.969634175	0.97988205	7.431112863	21.93159293	14.59220235	210.6557261	0.905782392	16.41995716	216.4525146	0.562765233	0.344449968
1993	Chinook_1	0.914574886	0.714940321	0.653866462	123.84	127.48	134.63	0.018910629	12354.14991	11.60901407	7.905177757	12.12949287	10.74484444	87.90304018	0.964895976	0.876413345	7.239695139	23.54121715	12.22653866	269.2114563	0.871506065	16.83012795	292.7973938	0.743943145	0.526308105
1994	Chinook_1	0.93426914	0.45523677	0.425313666	129.4	132.84	137.85	0.017766331	7549.861199	11.15805251	5.915153168	14.80606142	13.13755341	61.05918503	0.976181746	1.093953323	7.064849511	23.36063654	14.85086255	214.4558055	0.905860394	16.7173934	220.9073334	0.570382168	0.305089951
1995	Chinook_1	0.905557242	0.610222343	0.552591262	131.64	135.24	141.6	0.015459903	8534.399464	11.50233214	8.968438603	11.03083773	11.63440666	96.75101929	0.970095873	1.052272797	6.824834332	24.75212459	13.96780952	263.1435572	0.869932761	17.00245825	275.2388611	0.645185947	0.453328524
1996	Chinook_1	0.941996149	0.509598544	0.480039866	142.48	145.12	147.27	0.012745749	6112.984685	12.41856074	5.232040435	16.96101494	14.07700405	122.1772705	0.957944131	1.182934475	6.117490284	28.30317574	15.09226036	329.8155212	0.823770801	18.03076315	339.9545288	0.615747921	0.360428156
1997	Chinook_1	0.946483089	0.545813906	0.516603632	135.34	137.94	140.26	0.015470678	7986.065159	15.54184324	4.791926585	18.32558962	12.90720158	161.2550079	0.961831455	1.454152775	5.643941194	31.7458262	14.82599624	466.9888865	0.802331487	22.55190325	477.5127258	0.641513992	0.410694697
1998	Chinook_1	0.897520841	0.616904132	0.553684315	121.4	125.16	131.65	0.018807835	10403.29145	12.40403012	9.720274307	10.83891049	11.33827896	108.0198166	0.963042951	1.070991135	6.891332634	24.86088313	14.00749095	341.8098043	0.824360291	17.93805154	355.5706482	0.647388977	0.439121395
1999	Chinook_1	0.910314767	0.603042468	0.548958463	124.08	127.41	134.46	0.018645182	10226.49111	11.68676703	8.407989465	11.63040329	11.50208092	96.98786316	0.977349925	1.15023365	7.260104343	22.83742931	13.99814749	254.5374934	0.886873225	17.4841164	257.638031	0.662074213	0.429007093
2000	Chinook_1	0.939129692	0.444206267	0.417167294	132.87	136.43	138.75	0.017118998	7136.000561	11.6743084	5.46339988	16.04267226	13.15479259	85.86859283	0.983289921	1.237781048	6.794367	24.42740991	15.0531497	243.4088593	0.892071575	17.53062073	251.6460419	0.578700319	0.290036662
2001	Chinook_1	0.866582629	0.56937164	0.493407572	118	123.26	131	0.019279807	9503.974415	9.683152028	12.85289158	8.470676395	10.97311344	51.79628448	0.941249418	0.80097723	8.183424525	19.58016227	13.95881287	151.4381994	0.908760846	14.20861101	160.840744	0.62069563	0.37477051
2002	Chinook_1	0.907167293	0.651018825	0.590582985	123.39	127.53	134.42	0.018333961	10816.17539	11.45933758	8.665487133	11.11645865	10.99778099	68.43727264	0.982338631	1.135490227	7.325115487	22.59505424	13.29346832	233.6345444	0.900170207	17.1726834	239.8310852	0.692218387	0.48447093

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Appendix E: Fish, Aquatic Macroinvertebrates, and Aquatic Habitat

Year	Species	InRivSurvSNK	InRivSurvLCol	InRivSurv	MedDayLGR	MedDayConfl	MedDayBON	SAR	TotalReturn	meanGas	SNKTravelTime	SNKMigRate	SNKTemp	SNKFlow	SNKFSpill	SNKGas	LCTravelTime	LCMigRate	LCTemp	LCFlow	LCFSpill	LCGas	BonFlow	monte_q975	monte_q025
2003	Chinook_1	0.922419221	0.613440121	0.565848959	132.44	136.2	143.41	0.015697272	8873.612551	11.7033611	7.172438771	12.77779744	11.74065323	79.32934418	0.975928009	1.075335503	6.83854147	24.63302515	13.93913349	254.4398193	0.884607742	17.19712782	275.8760986	0.658540896	0.450808519
2004	Chinook_1	0.857281573	0.609956515	0.522904481	116.72	122.82	129.96	0.019316241	10090.06253	11.1859107	13.85596245	8.164782722	10.67100582	64.00260239	0.977384746	0.977604866	7.730462141	21.09205076	13.67416636	222.7172724	0.899199078	16.63413207	247.6680145	0.637184921	0.386016776
2005	Chinook_1	0.913500082	0.535140771	0.488851138	125.9	129.56	135.24	0.017985912	8783.006571	11.14835531	8.044193149	12.06751822	12.76865902	73.70869293	0.975040579	1.026327229	7.200680412	22.85319336	14.6706473	226.0914027	0.89683342	16.57814709	237.0324249	0.607109311	0.360889378
2006	Chinook_1	0.9220316	0.70461293	0.649675388	123.43	126.76	133.69	0.019099115	12395.55074	12.14241372	7.201533936	13.23062203	10.84738789	128.2048233	0.975634634	1.15542841	7.118512742	23.78443816	12.5982097	293.9065145	0.864635895	17.95979023	302.4699097	0.74425551	0.520579903
2007	Chinook_1	0.907253244	0.558401658	0.506611715	124.07	127.7	133.7	0.018318887	9270.186426	11.65544173	8.722811095	11.39217949	12.55857658	74.40320435	0.981365502	1.157709789	7.106451534	23.26193083	14.50571998	255.9834391	0.884328038	17.42003934	265.168335	0.620780108	0.379962908
2008	Chinook_1	0.841167728	0.677696541	0.57005646	117.74	123.79	131.21	0.01896472	10801.45058	10.78834159	15.89177936	7.332983187	10.52701874	73.00832138	0.961367249	0.850131035	7.793945424	20.98398131	12.57913319	213.8724162	0.896374792	15.76177502	229.9109497	0.65609558	0.469412555
SCN MO3-RESSIM-SAL																									
1929	Chinook_1	0.928357245	0.663241138	0.615724715	124.99	127.68	135.22	0.018773299	11550.5136	9.438097358	4.620796092	18.69584258	11.09575596	54.09363785	0.926754498	0.75318675	8.239862502	19.73869295	12.64982144	143.4582901	0.897204896	13.82458091	155.3191376	0.721357667	0.479128455
1930	Chinook_1	0.905715686	0.669794688	0.606643556	103.93	109.4	117.55	0.018480173	11199.03957	9.315341473	7.829573594	11.69708146	9.682554626	59.33450851	0.933146691	0.663420486	9.006323993	17.48631561	11.43564685	148.2828293	0.905412883	13.47640864	156.6886139	0.667089083	0.493489616
1931	Chinook_1	0.897166759	0.673322238	0.60408233	106.55	111.67	119.89	0.018933895	11425.90796	8.909744757	8.50026194	10.74549776	9.566019058	42.97081604	0.917611587	0.655017328	9.133262418	17.29348145	11.54120938	133.7082278	0.888176262	12.97230148	142.1733398	0.683598455	0.506085085
1932	Chinook_1	0.929680119	0.738292445	0.686375809	117.64	120.5	127.92	0.019415569	13315.93128	11.64225657	4.995455891	17.43620728	10.32642632	82.57201233	0.970048988	1.024285984	7.953401983	20.77201338	11.68748871	272.6408437	0.863793353	17.21590281	287.9810181	0.775746599	0.561399976
1933	Chinook_1	0.927657514	0.618050463	0.573339156	131.16	133.78	140.84	0.017058653	9769.590473	11.26841576	4.46476157	19.48336896	11.63727741	56.05530777	0.977275312	1.101433849	7.218110833	22.94945364	13.71609894	217.1445516	0.905762897	16.87788757	226.084259	0.689152871	0.452978439
1934	Chinook_1	0.921984172	0.63430988	0.584823669	114.54	117.26	123.05	0.019012535	11107.61216	11.93448608	5.161730133	16.98495696	11.14434586	78.89875641	0.962951398	1.109517002	7.910318844	20.61534151	12.78478209	307.4966736	0.842089842	17.69121091	314.8917542	0.655469419	0.491222539
1935	Chinook_1	0.928366336	0.589334152	0.547117987	125.64	128.12	135.22	0.018355195	10032.63339	11.14251763	4.243967913	20.44746447	11.80034485	62.74397888	0.97624929	1.038751221	7.412624091	22.16636332	13.94932238	216.542689	0.904879669	16.62836742	228.7690125	0.66520685	0.41529457
1936	Chinook_1	0.942923685	0.725787638	0.684362348	116.42	118.93	126.3	0.019637061	13426.18374	11.86870698	4.132692635	20.95292764	10.02758312	127.4037766	0.977493989	1.1084198	7.855603978	21.14027477	11.43790976	291.1034139	0.861323029	17.60401789	302.5303955	0.747185788	0.578085168
1937	Chinook_1	0.919801304	0.671146326	0.617321266	124.7	127.36	134.41	0.018664225	11509.30278	10.07727953	5.835220024	15.54447275	10.68247204	54.94858475	0.945712519	0.810753727	8.06501469	20.20556713	12.69368696	171.4309845	0.902765075	14.81843249	185.1851654	0.718340843	0.486177493
1938	Chinook_1	0.94280135	0.629521195	0.5935134	129.62	131.99	136.6	0.017071435	10122.72197	12.00351555	3.458891086	24.76891889	11.4953577	108.5496277	0.969272459	1.14256773	6.970343128	24.20331774	13.50309261	294.8815918	0.855849624	17.72454214	304.1505737	0.68442386	0.500519153
1939	Chinook_1	0.932663434	0.731213437	0.681976035	116.26	119.3	126.59	0.019587993	13345.93513	11.16653105	4.777873665	18.23326605	10.25021286	84.20984497	0.97961868	0.95206461	8.087913424	20.14072318	11.32936859	227.6637472	0.901059459	16.67254194	237.4466248	0.743088443	0.565992173
1940	Chinook_1	0.897181013	0.742712704	0.666347736	95.01	101.29	110.51	0.016450009	10949.51181	9.802108662	9.067651533	10.05293569	8.90916481	83.4686203	0.863576819	0.572818279	9.460835293	16.85600007	10.30773735	196.2595113	0.822981685	14.14470164	207.3538208	0.727145559	0.527705986
1941	Chinook_1	0.918098565	0.493396161	0.452986307	132.94	135.1	136.13	0.016191668	7327.563683	10.41049198	4.073638529	21.2303918	13.41648827	57.05632095	0.962566257	0.89277029	7.49218528	21.56433934	14.66070016	182.6404419	0.910226603	15.4824791	189.6040039	0.579117487	0.338307767
1942	Chinook_1	0.935438284	0.671149153	0.627818612	135.78	137.98	144.35	0.015228612	9550.248597	11.05712261	4.391121432	20.29452976	11.2254137	82.89598694	0.965047085	0.956099224	7.113450147	23.64040405	13.0600117	235.5717392	0.881979436	16.31633027	248.7467804	0.714020939	0.532304464
1943	Chinook_1	0.935659055	0.711297359	0.665531815	122.41	124.62	130.88	0.01863345	12388.47748	11.72582323	4.952138975	18.10939747	10.18534355	122.8862	0.960627377	1.063215733	7.834138677	21.07599561	12.05594778	286.7305196	0.853049695	17.32240311	291.9794312	0.749021977	0.563169822
1944	Chinook_1	0.931310454	0.590925301	0.55033491	130.65	133.04	140.48	0.016981049	9336.897777	10.07594139	4.167114973	20.84824354	11.71320038	62.59826965	0.951079655	0.863035774	7.579258025	21.58965751	13.79551586	165.8682454	0.913728426	14.90815695	173.5161591	0.67228397	0.423043543
1945	Chinook_1	0.924807161	0.689729067	0.63786638	118.92	122.12	129.29	0.01933525	12321.88067	10.52537233	5.181002282	17.04313545	10.72434158	67.20752563	0.950236261	0.799880028	8.039165817	20.33454015	12.31391048	203.023379	0.89194365	15.49829809	220.8336029	0.725533353	0.532332943
1946	Chinook_1	0.935184073	0.771101909	0.721122224	110.64	113.62	121.65	0.019541975	14080.43201	12.05360048	5.259769082	16.71379025	9.310554695	114.8619568	0.964967299	0.97758646	8.329153091	19.90520286	10.59236765	320.6518351	0.841193825	17.63082536	335.6883545	0.784962064	0.571880426
1947	Chinook_1	0.927380933	0.690091069	0.6399773	110.45	113.93	121.7	0.019445428	12433.51031	11.49793938	5.478531554	16.12173416	9.992050362	86.89625397	0.975447917	0.955011559	8.201914877	19.67619356	12.03587262	258.8485896	0.881453454	17.00418901	274.0377502	0.712865347	0.532115202

Columbia River System Operations Environmental Impact Statement
Appendix E: Fish, Aquatic Macroinvertebrates, and Aquatic Habitat

Year	Species	InRivSurvSNK	InRivSurvLCol	InRivSurv	MedDayLGR	MedDayConfl	MedDayBON	SAR	TotalReturn	meanGas	SNKTravelTime	SNKMigRate	SNKTemp	SNKFlow	SNKFSpill	SNKGas	LCTravelTime	LCMigRate	LCTemp	LCFlow	LCFSpill	LCGas	BonFlow	monte_q975	monte_q025
1948	Chinook_1	0.945119325	0.630634255	0.596024622	132.96	134.96	138.86	0.016586742	9877.41146	14.36502644	3.100323163	27.59181269	12.01188374	133.5401215	0.973454964	1.3467103	6.212298058	28.01236613	13.74781593	402.7114919	0.841107508	21.22118648	422.3431396	0.682546329	0.501276969
1949	Chinook_1	0.941611146	0.574674346	0.541119764	126.06	128.17	134.11	0.018041006	9755.164467	12.70623715	3.166792646	26.95728627	12.16335049	118.1861816	0.971138489	1.203732204	6.761429861	25.21350864	14.31419945	330.6573639	0.840229799	18.30280765	355.2485352	0.647447379	0.424858619
1950	Chinook_1	0.94036978	0.687996791	0.646971392	132.28	134.4	140.46	0.01730984	11187.14059	11.58511996	3.772573136	22.84777049	11.26592464	89.06238098	0.978500319	1.076886272	6.988166861	24.20840262	12.89646228	267.0198491	0.874024898	17.15627495	283.9216003	0.746000954	0.524038509
1951	Chinook_1	0.940750052	0.646071863	0.607792138	130.78	132.73	139	0.017169196	10424.32708	12.55734726	3.752009198	23.14820785	11.39031487	105.1453979	0.962851048	1.160851383	6.658380553	25.74358342	13.61442757	341.0569051	0.828355054	18.19307852	356.8728027	0.700071326	0.507302038
1952	Chinook_1	0.948563121	0.724390861	0.687130455	125.29	127.26	133.33	0.018497978	12698.39637	12.59995409	3.539834403	24.41712368	10.65001907	157.7332123	0.952232862	1.073069286	7.074994273	24.33571603	12.19411977	355.3974406	0.815536181	18.17764521	369.6945496	0.766291828	0.56966498
1953	Chinook_1	0.932248763	0.670684269	0.62524458	132.34	134.84	141.54	0.01581472	9877.144243	11.33277103	4.667881675	18.88274721	11.04626389	82.66471863	0.963035846	1.003823853	7.136217594	23.47014072	13.06417243	255.5237986	0.868219296	16.66242027	270.4333191	0.700204153	0.530137758
1954	Chinook_1	0.942225263	0.690524188	0.650629334	139.47	141.18	145.81	0.014798377	9618.560258	12.09317327	3.857077681	22.60513913	11.16204472	101.815036	0.961155427	1.094530773	6.591175959	26.00215234	12.97707033	310.8389537	0.843387206	17.71063169	320.8485107	0.739217437	0.548357117
1955	Chinook_1	0.939907352	0.649376869	0.610354094	135.09	137.18	143.15	0.016044114	9782.246571	11.21886454	3.834919341	22.61800312	11.27868443	84.46255035	0.973273134	1.015513134	7.003823698	23.97905391	13.45767927	236.9499054	0.889005661	16.6441342	249.4746857	0.710309469	0.498224031
1956	Chinook_1	0.942830813	0.730517814	0.688754705	117.66	119.99	126.59	0.018336651	12616.7358	13.54564531	4.175037801	20.7840104	10.15770817	138.2622681	0.960046601	1.195939445	7.436139166	22.84295589	11.65557337	391.1296692	0.815131992	19.64155881	407.0189819	0.745299557	0.598098587
1957	Chinook_1	0.93420003	0.712891317	0.66598309	117.2	120.63	126.48	0.017264897	11485.62665	12.4783505	4.874808751	18.01972988	10.44516907	121.3573898	0.958111489	1.010146332	7.471507877	22.06259203	11.87573687	318.8364512	0.847169886	18.07206059	334.7771301	0.724474882	0.586036635
1958	Chinook_1	0.945098289	0.677484047	0.640289013	127.42	129.53	134.74	0.017588408	11253.74243	12.62359684	3.369606204	25.3395453	11.3269207	118.6450653	0.97117933	1.12254343	6.706416637	25.75250368	12.97368447	334.4650167	0.838060091	18.29690504	355.6206055	0.721605223	0.541177968
1959	Chinook_1	0.937574189	0.618540239	0.579927363	136.17	138.11	143.74	0.015487596	8973.340495	11.9423462	3.689203463	23.2951907	11.81298332	81.67079468	0.978894567	1.168298054	6.679508828	25.37194204	13.89189736	285.24322	0.864681234	17.72503026	295.7714539	0.680907938	0.472769548
1960	Chinook_1	0.939273595	0.643443154	0.604369164	134.4	136.23	141.46	0.016560174	9998.075631	11.64194281	3.949062288	21.99997941	11.22958927	87.2541687	0.973897505	1.129856777	6.921292625	24.31964034	13.52531926	263.1848272	0.874287566	17.33599822	272.0845642	0.708676601	0.488229596
1961	Chinook_1	0.919747768	0.655184248	0.60260425	118.75	121.99	128.36	0.01847832	11124.42424	11.24106373	5.695669383	15.6826935	10.75580101	61.61362991	0.969704497	0.983410835	7.83823806	20.7723757	12.90828292	236.7375488	0.886421273	16.64094766	246.044754	0.689868878	0.505605335
1962	Chinook_1	0.936064364	0.702404429	0.657495756	119.62	122.22	129.44	0.019364029	12718.34469	11.51017186	4.443298809	19.54585256	10.53264713	89.14200134	0.982349348	1.115723515	7.789803714	21.19423823	12.25125249	248.4126867	0.886856963	17.22060442	254.2181549	0.742019176	0.527336656
1963	Chinook_1	0.922118709	0.634666021	0.585237412	118.22	121.31	127.76	0.018618624	10884.29018	10.52154963	5.453058347	16.24292243	10.84863815	68.49351196	0.95689857	0.851952267	8.091965444	19.923644453	12.95043262	198.5020243	0.901066542	15.5339032	208.074707	0.671159652	0.489117992
1964	Chinook_1	0.942494274	0.626186666	0.590177347	133.63	135.81	142.01	0.01631529	9618.75833	11.59098104	3.510752045	24.59205289	11.49808865	92.38935547	0.971550941	1.038137913	6.662766531	25.67829191	13.98245637	273.5558395	0.866659204	17.07802057	288.6371155	0.714211087	0.451514877
1965	Chinook_1	0.941251681	0.531608693	0.500377576	144.43	145.95	145.77	0.013674135	6836.316417	12.33659666	2.765829861	30.83941682	13.28970165	135.6426117	0.95936054	1.166245174	6.334494241	27.24293899	14.3451252	328.1638082	0.822462718	17.9994429	335.7718811	0.597366596	0.418367164
1966	Chinook_1	0.91776341	0.710897239	0.652435474	111.14	115.02	123.11	0.019398043	12643.02082	10.34324799	6.198017053	14.27082342	10.03481083	60.78222275	0.964766836	0.850830936	8.59162011	18.60154749	11.39542777	186.8302892	0.908937355	15.27993361	197.0668335	0.716803651	0.550772086
1967	Chinook_1	0.927480631	0.721887857	0.669537006	125.08	128.22	135.24	0.018387265	12299.13864	10.91832117	5.019380093	17.31911221	10.62183495	56.82792053	0.961050284	0.904004383	7.594456963	21.87951701	11.98006455	224.894165	0.889247576	16.05786689	238.1805573	0.744087681	0.550486151
1968	Chinook_1	0.921347794	0.433878443	0.399752947	139.77	141.64	143.16	0.014983956	5984.704386	10.72303346	3.302830435	25.87403081	14.55237217	69.4795929	0.95501703	0.969315243	6.919244632	23.69058379	15.31413603	219.2219823	0.877092779	15.81810188	229.0761261	0.574595784	0.283075587
1969	Chinook_1	0.937039861	0.679561201	0.636775933	117.41	119.97	126.7	0.019067885	12130.12997	12.24131935	4.547307834	19.23751374	10.33544292	112.4046646	0.969492793	1.145501614	7.639783129	21.72053702	12.68086195	315.5476278	0.841802905	17.97409534	322.7494507	0.724912853	0.536266298
1970	Chinook_1	0.933650678	0.691826851	0.645924608	127.1	129.39	135.9	0.016863251	10882.2678	10.68209999	4.516891666	19.27573168	10.8926691	86.61368408	0.948676729	0.861142731	7.501571	22.1127754	12.47384771	224.7757111	0.874355048	15.67931422	233.5615387	0.712595866	0.547157878
1971	Chinook_1	0.950421234	0.635299045	0.603801702	138.89	140.6	144.3	0.015043949	9076.155237	13.86327008	2.661568828	31.93759469	12.33267479	152.385495	0.95882988	1.256460953	5.781855084	31.1080233	13.9498388	419.086085	0.786630968	19.87769381	424.659668	0.70157818	0.504828537
1972	Chinook_1	0.942491373	0.648699162	0.611393364	125.5	127.69	133.13	0.017308821	10573.35491	13.41639478	3.54624708	24.20599601	11.46660709	119.6628113	0.975463521	1.250487137	6.699467972	25.29543562	13.5370868	365.7953695	0.837643961	19.73050499	367.8673706	0.691404906	0.518435254

Columbia River System Operations Environmental Impact Statement
Appendix E: Fish, Aquatic Macroinvertebrates, and Aquatic Habitat

Year	Species	InRivSurvSNK	InRivSurvLCol	InRivSurv	MedDayLGR	MedDayConfl	MedDayBON	SAR	TotalReturn	meanGas	SNKTravelTime	SNKMigRate	SNKTemp	SNKFlow	SNKFSpill	SNKGas	LCTravelTime	LCMigRate	LCTemp	LCFlow	LCFSpill	LCGas	BonFlow	monte_q975	monte_q025
1973	Chinook_1	0.91319327 2	0.61408111	0.56077473 8	121.06	124.33	129.92	0.01686084 7	9445.15459	9.58375024 8	6.07840122 3	14.7232677 1	11.0720153 8	50.6175529 5	0.92548811 4	0.80842475 9	8.16821757 7	19.7444565 6	13.0306903 5	158.130017 6	0.88098368 9	14.1588989 9	165.07901	0.63708695 1	0.47987724 8
1974	Chinook_1	0.94596126 9	0.60341346 2	0.57080576 5	135.51	137.44	142.07	0.01560215 7	8898.67147 5	13.6069950 7	2.91780377 2	29.2148402 7	12.3543067 9	135.994458	0.95930578 7	1.26362791 1	6.12163268 8	28.6847988 2	14.3066783 2	396.868845 6	0.80630640 2	19.7774510 4	401.187439	0.67070397	0.45585484
1975	Chinook_1	0.94676303	0.60951038 5	0.5770619	145.26	147.18	150.99	0.01203177 3	6937.52759 2	12.4679226 2	2.86618661 9	29.7257753 4	12.3612060 5	125.918592 8	0.96829737 4	1.19762554 2	6.14050102 2	28.3011652 6	14.0719550 5	326.493118 3	0.83114987 6	18.1563986 1	333.554199 2	0.67115784 7	0.48701996
1976	Chinook_1	0.94451281	0.74312619	0.70189220 6	121.33	123.77	130.81	0.01916643 4	13440.0595 3	12.4566208 3	3.95424196 9	21.8310186 1	10.2692001 3	120.896826 2	0.97451682 1	1.16097583 8	7.36122240 9	23.0434413 6	11.8003694 2	323.561503 1	0.84323358 5	18.1784079 9	334.282074	0.78257965 6	0.60004534 4
1977	Chinook_1	0.90978644 8	0.52927718 1	0.48152920 7	129.65	132.32	137.5	0.01665935 7	8014.01543 4	9.31432376 6	5.04758527 9	17.3820022 4	12.7398771 3	37.8946044 9	0.93346953 4	0.80447979	7.98530795 4	20.0875807 3	14.2613188 4	138.808606 5	0.90008078 1	13.6711281 1	144.924621 6	0.59263873 4	0.36375750 9
1978	Chinook_1	0.92352572 9	0.74789709 1	0.69070220 6	109.73	113.34	121.59	0.01871217 1	12910.0911 7	11.2556036 5	6.24791413 5	14.3602935 1	9.53301906 6	87.9195175 2	0.96960719 8	0.94009437 6	8.41758234 8	19.1692382 6	11.0694489 5	243.031328 8	0.87990578	16.7283872	256.305236 8	0.75615402 1	0.56419762 1
1979	Chinook_1	0.91669672 2	0.74606971 2	0.68391965 9	112.4	115.78	124.12	0.01949940 1	13321.9575 4	10.4638638 7	6.55615068 2	13.7277540 6	9.73767547 6	61.2851333 6	0.94591938 3	0.73259444 2	8.61797612 9	18.8231395 1	11.0458498 1	200.534189 9	0.88817496 1	15.3099280 2	223.416626	0.75304796 9	0.53841372 4
1980	Chinook_1	0.94623682	0.64251912 9	0.60797525 7	136.29	138.34	144.08	0.01479172 1	8986.25379 1	12.3225806 4	3.15119205 4	27.1280957 5	11.6954643 2	110.116003 4	0.95994111 3	1.14569234 8	6.43753928 7	26.9974705 7	13.8182234 8	330.392801 9	0.83071511	18.0730621	336.858978 3	0.69980495 7	0.51035043 2
1981	Chinook_1	0.91696826 7	0.55128142	0.50550756 8	128.43	130.94	130.37	0.01607038 1	8115.25200 8	10.8314283 6	5.08618327 2	17.4826575 7	12.6861244 2	78.5646896 4	0.94611504 1	0.91703214 6	7.46695824 1	21.7256567 1	13.9236545 6	233.946108 5	0.86710406 3	15.8958050 4	243.151718 1	0.61423785 5	0.40212988
1982	Chinook_1	0.94230984 8	0.54725359 9	0.51568245 6	142.91	144.55	146.01	0.01372179 3	7070.42830 8	12.8958684	2.85655515 6	29.8433595 5	13.1568460 5	125.309358 2	0.96840493 7	1.23222379 7	6.09917175 8	28.4138343 7	14.7323323 9	351.944142 7	0.82317132 8	18.7740866 3	356.706543	0.65431396 1	0.40211493 3
1983	Chinook_1	0.93479413 6	0.64097775 7	0.59918224 8	123.11	125.5	130.4	0.01627493 1	9742.44478	11.6919376 5	4.24038975 7	20.5243527 4	11.3632022 9	101.279345 7	0.96992777 6	1.05775070 2	7.30207727 8	22.6815931 3	13.2340164 2	278.868774 4	0.85858405 6	17.2267527 6	286.971435 5	0.66931768 8	0.51255467 3
1984	Chinook_1	0.94400516	0.61126674 2	0.57703895 9	129.19	131.42	136.5	0.01684233 4	9711.05959 2	11.7309928 6	3.10240005 7	27.4295744 1	12.1436105 7	123.344836 4	0.97795428	1.13480243 7	6.91223751	24.3597486 7	13.6511775 7	269.898625 7	0.87006711	17.458378	275.062774 7	0.67478943 1	0.47292285 6
1985	Chinook_1	0.92996264 4	0.75249312 5	0.69979049 6	109.72	112.84	121.24	0.01898311 4	13271.2559	11.2435151 8	5.81644464 3	15.3322673 2	9.25979309 1	107.282463 1	0.96892061 2	1.00741567 6	8.59794075 8	18.7648399 5	10.8266967 1	237.331550 6	0.88923860 6	16.8547215 5	239.834365 8	0.75631735 1	0.56700184 6
1986	Chinook_1	0.93011917 8	0.61181790 9	0.56906357 1	122.65	125.02	127.55	0.01673717 4	9515.06624	11.4480219 6	4.70420940 2	18.7219574 3	11.2704170 2	104.333673 1	0.96824551 8	1.04033870 7	7.66722165	21.1335347	12.9616742 1	254.294891 4	0.87046584 5	17.0090875 6	256.827972 4	0.63949750 6	0.49232063 4
1987	Chinook_1	0.91699956 8	0.55806189 5	0.51174251 7	117.95	120.58	126.56	0.01973913 2	10094.2444 3	11.3778448 8	4.62980657 8	18.8189876 3	12.3189920 4	57.8282501 2	0.97296229 6	1.03336334 2	7.70487498 5	21.1258298 8	13.7583677 2	250.398241 7	0.88065291 4	16.8565189 1	264.822174 1	0.61542768 4	0.40542025 2
1988	Chinook_1	0.90785169 1	0.73467383 7	0.66697488 5	109.15	112.86	121.19	0.01904841 6	12691.4279 7	10.2695061 1	7.91055266 6	11.7224619 8	9.33599414 8	59.4756111 1	0.95315523 1	0.77942676 5	8.81867884 1	18.0873303 4	10.8949394 2	183.342308	0.91038668 2	15.2003348 7	190.345977 8	0.72821502	0.54362429 3
1989	Chinook_1	0.94090868 3	0.56967737 9	0.53601439 3	141.85	143.9	148.51	0.01425079 7	7632.88591 1	11.5687711 6	3.40948284 4	24.9760800 8	11.8173051 8	78.1246902 5	0.98206045 6	1.16217670 4	6.81408819 6	24.7397323 1	14.2962760 9	242.450681 1	0.89302722 6	17.3279937 1	246.548507 7	0.66875526 5	0.40903777
1990	Chinook_1	0.92318959 4	0.43560972 9	0.40215036 9	131.6	133.82	138.24	0.01769793 9	7111.31213 1	11.1312095 4	3.43122501 7	24.8303309	13.8831363 7	62.9638542 2	0.97900294 1	1.13755617 1	7.10595274	22.9790312 3	15.3372281 4	212.435780 8	0.90887566 4	16.7188520 4	211.224182 1	0.59097320 4	0.27526924 4
1991	Chinook_1	0.92111316	0.64141759 5	0.59081818 8	123.59	126.65	131.76	0.01750544 7	10331.9437 7	11.3199747 6	5.41779596 4	16.3955201 6	11.0617485	60.4889595	0.96598036 3	1.00099353 8	7.50817123 1	21.8904170 4	13.1182986 9	250.612004 6	0.87735981 7	16.7591478	252.178344 7	0.67603114 5	0.50492424 3
1992	Chinook_1	0.91081005 2	0.54607624 9	0.49737173 7	121.11	123.73	128.33	0.01911067 5	9495.23441 6	10.4947863 3	4.77507576 3	18.2305727 6	12.7980382 9	49.3028411 9	0.96046384 6	0.87432937 6	7.92459575 1	20.2089230 2	13.7272489 9	192.460428 9	0.90686903 4	15.5979884 5	198.336532 6	0.59284011 7	0.40656810 9
1993	Chinook_1	0.93382188 3	0.72958478 3	0.68130223 6	120.74	123.53	131.05	0.01940101 3	13206.3373 9	10.8271852 4	4.60234181 6	18.7982144 6	10.4498430 3	78.1547088 6	0.95151872 6	0.75796513 6	7.92409876 7	20.8958873 4	11.6379262 6	221.881696 1	0.88929757 5	15.8051986 7	240.267227 2	0.76335659 3	0.55899940 1
1994	Chinook_1	0.92472404 6	0.47990910 4	0.44378348 8	128.68	130.92	136.18	0.01820427 3	8071.91086	11.1347366 7	3.67144666 6	23.3348281 3	12.9633976	60.6407226 6	0.97617324 6	1.07837600 7	7.22426499 4	22.7414991 7	14.6322026 3	213.320676 2	0.90658009 1	16.6626579	221.342575 1	0.56729706 3	0.34639605 8
1995	Chinook_1	0.93118951 9	0.64961319 9	0.60491300 2	127.36	129.61	135.21	0.01631507 2	9859.27022 9	11.0604142 8	4.72997969 4	18.6447366 8	11.0906539 9	92.0855377 2	0.95987755 1	0.96907510 8	7.43639734 4	22.1188784 5	13.0687232 5	240.971888 2	0.87411732 5	16.3110143 3	250.928665 2	0.67786338 5	0.52088401 2
1996	Chinook_1	0.93648333 9	0.53655690 2	0.50247659 9	140.7	142.07	143.9	0.01355114	6803.03368 7	12.4155429 1	2.89429672 1	29.4543511 2	13.7460344 3	122.270071 4	0.95848118 1	1.16858911 5	6.34326464 7	27.0519043 3	14.6632601 4	331.600840 3	0.82404004 5	18.0408029 6	342.444183 3	0.63274928 4	0.40429976 7
1997	Chinook_1	0.94643054 9	0.56620245 4	0.53587129 9	134.64	136.19	138.76	0.01590094 3	8514.32010 1	15.3632596 6	2.68564248 8	31.7096264	12.7191265 1	161.879818 7	0.96177349 1	1.42484169	5.84629199 7	30.3360225 4	14.5032938 3	462.8523	0.80106705 4	22.3014346 8	471.997985 8	0.64949354 2	0.43113015 9

Columbia River System Operations Environmental Impact Statement
Appendix E: Fish, Aquatic Macroinvertebrates, and Aquatic Habitat

Year	Species	InRivSurvSNK	InRivSurvLCol	InRivSurv	MedDayLGR	MedDayConfl	MedDayBON	SAR	TotalReturn	meanGas	SNKTravelTime	SNKMigRate	SNKTemp	SNKFlow	SNKFSpill	SNKGas	LCTravelTime	LCMigRate	LCTemp	LCFlow	LCFSpill	LCGas	BonFlow	monte_q975	monte_q025
1998	Chinook_1	0.92608956 1	0.67406021 3	0.62424012 6	116.01	118.99	125.79	0.01904415 1	11876.3433	11.5716102 5	5.38871359 8	16.4703756 2	10.5262386 3	89.6757202 1	0.95481376 6	0.90176849 4	7.78899120 5	21.1402588 3	12.7132930 8	281.471249 9	0.85408882 3	16.7684906 3	300.252563 5	0.71853303 9	0.53216318 4
1999	Chinook_1	0.93349878 9	0.64459539 6	0.60172902 2	121.06	123.27	129.54	0.01907944 7	11470.6302 9	11.6595821 7	4.46063334 5	19.5985164 2	10.9731260 3	99.1037216 2	0.97242169 4	1.08343019 5	7.73193557 6	21.2079984 7	13.1170549 4	269.223119 1	0.87225558 4	17.3683306 4	273.265075 7	0.70489903 2	0.49413182 2
2000	Chinook_1	0.93412853 1	0.49276822 4	0.46030885 7	131.06	133.15	136.31	0.01766717 3	8126.11015 7	11.6846584 6	3.30756994 3	25.8638010 2	12.7528682 7	87.1113754 3	0.98261500 6	1.21418380 7	6.99278290 6	23.6628869 5	14.5534677 5	248.822263 1	0.88880568 7	17.5360832 2	256.733459 5	0.58218179 5	0.36518694 5
2001	Chinook_1	0.90199811 4	0.67206265 3	0.60619924 3	110.85	115.27	123.45	0.01931823 5	11699.8355 6	9.15733933 4	7.73220554 7	11.8147118 1	9.81228923 8	40.8448951 7	0.90403831 1	0.64238100 1	8.96501272 9	17.7976576 3	12.1613111 5	138.655099 2	0.88700458 4	13.3344348 3	150.542144 8	0.69614527 3	0.49762199 8
2002	Chinook_1	0.93066498 3	0.69292939 9	0.64488512 7	119.9	122.82	129.67	0.01894664 6	12205.3294 4	11.3914367 1	4.82839953 9	18.0292674 6	10.5459854 1	70.1148284 9	0.97959033 3	1.07222271 1	7.81386424 6	20.9550590 2	12.2830260 6	234.838986 7	0.89703891 7	17.0647791 2	242.425430 3	0.71967447 7	0.54335418 4
2003	Chinook_1	0.93399658 1	0.62632731 2	0.58498756 8	130.58	133.05	140.06	0.01651262 6	9650.25333 6	11.4670261 1	4.05864226 8	21.3261347 3	11.5436084 7	76.9099731 4	0.97288202 1	1.04174099 1	7.18804334 8	23.0665843 6	13.5767900 1	240.752555 8	0.88894245 5	16.9070415 5	260.435424 8	0.67832258 3	0.48042748 3
2004	Chinook_1	0.91167758 5	0.72230418 9	0.65850853 9	107.4	111.8	120.13	0.01888731 8	12424.5425 3	10.6568273 1	7.49185413 9	12.1318992 9	9.23925933 8	60.7109924 3	0.96134787 8	0.83169469 8	8.73085892 2	18.2370293 3	11.3111276 6	202.012980 1	0.90199677 1	15.7525398 7	219.833252 3	0.72625012 1	0.54751219 4
2005	Chinook_1	0.92065932 7	0.57965492 9	0.53366470 9	122.67	125.34	131.02	0.01858448 4	9907.25458 6	10.7523812 6	4.73747745 9	18.5562798 3	12.1553873 1	67.1325058 1	0.96641831 4	0.95613308 3	7.71384752 5	20.9697499 7	13.8873079 6	206.504074 1	0.90155000 5	15.9283212 3	216.198364 3	0.65553207 6	0.43553570 4
2006	Chinook_1	0.94467678 9	0.72814089 9	0.68785780 6	121.51	123.64	130.8	0.01938774 2	13322.3621 2	11.9867093 9	3.85383622 3	22.4557847 1	10.4294849 4	127.844493 1	0.97138330 9	1.13248920 4	7.55624827 7	22.1557346 9	11.9484774 3	291.843872 1	0.86127777 9	17.7899055 5	297.802612 3	0.77983168 1	0.55892845 1
2007	Chinook_1	0.92035154 4	0.60639403 6	0.55809568 7	120.87	123.23	129.44	0.01875035 1	10452.7681 1	11.4610587 2	4.95794104 8	17.8132838 2	11.8920492 2	68.4419937 1	0.97765219 2	1.09435491 6	7.63320594 3	21.2781430 2	13.6147646 9	243.746821 1	0.88926992 8	17.1324122 7	253.001861 6	0.65905552 2	0.45216563 2
2008	Chinook_1	0.90227475 2	0.73304850 9	0.66141116 2	107.41	112.13	120.28	0.01829577 9	12090.3854 6	9.85547282 1	8.15131697 1	11.1369262 1	9.57006855 8	60.8282920 8	0.91998839 4	0.67826924 3	8.81091756 4	18.1095035 1	11.0370634 4	180.987266 5	0.88660005 7	14.2392752 2	192.724639 9	0.72394612 9	0.55815927 9
SCN MO3-RESSIM-SNK																									
1929	Chinook_1	0.96242474 3	0.67558355 5	0.65019832 9	124.39	126.06	133.8	0.01906188 3	12384.6979 1	9.32808319 2	3.07643806 9	27.8254585 8	10.9665927 9	53.8904350 3	0.92658067 9	0.74520945 5	8.38912858 1	19.3356030 7	12.3873364 1	140.000066 1	0.89604578 4	13.6739482 1	150.793487 5	0.76048382 4	0.51900670 2
1930	Chinook_1	0.94626356 4	0.68571290 9	0.64886514 2	103.15	107.07	116.13	0.01842039 7	11939.7330 8	9.24419798 2	6.60027997 2	14.0615832 2	9.50874633 8	59.9248344 4	0.93879448 2	0.65988168 7	9.10141369 1	17.2891286 1	11.1871250 5	146.262102 8	0.90724057 1	13.3087909 2	154.938140 9	0.71591910 7	0.51781652 2
1931	Chinook_1	0.93910989 9	0.70095578 2	0.65827451 3	104.78	108.72	117.59	0.01870500 3	12300.4387 8	8.75454648 9	7.23600680 4	12.7467798 7	9.24134044 6	43.2674713 1	0.92151296 1	0.64471488 1	9.27436521 6	16.9942161 5	11.0549901 3	130.881050 1	0.89099991 3	12.7577788 3	137.586868 3	0.73086735 1	0.51858173 8
1932	Chinook_1	0.96861601 5	0.74460190 2	0.72123332 7	117.02	118.91	126.46	0.01955798 3	14094.8311 8	11.6345606 5	3.85310279 6	22.8240626 6	10.2576286 3	82.3030639 6	0.97229521 3	1.01047744 8	8.06268747 2	20.3600587 3	11.4943763 4	269.799291 2	0.87245978 9	17.2728988 3	283.776550 3	0.80672555 7	0.58382751 9
1933	Chinook_1	0.95729473 3	0.61367758 2	0.58747031 7	130.71	132.5	139.54	0.01749043 2	10263.7798 4	11.2738839 9	3.23397834 6	26.7225236 4	11.6545454 4	55.9201141 4	0.97769212 7	1.10491533 3	7.28441292 8	22.6373805 8	13.7372872 3	216.723541 3	0.90782360 2	16.9046169 9	224.429855 3	0.70280659 2	0.45579895 3
1934	Chinook_1	0.95427573 8	0.65098493 4	0.62121912 8	113.85	115.54	121.58	0.01904332 6	11817.9740 1	11.960009 1	4.18017636 2	21.2267469 7	10.9795700 1	79.7323608 4	0.96472314 6	1.10351457 6	8.01865407 1	20.2949877 6	12.5380760 8	308.328664 1	0.84503722 2	17.7421212 2	315.405273 4	0.69617484 8	0.52236318 1
1935	Chinook_1	0.95882055 9	0.59410214 3	0.56963734 6	125.13	126.81	133.87	0.01863849 5	10606.8148 2	11.0968712 4	2.92802614 4	29.3674052 4	11.7385778 4	62.6598846 4	0.97575582 3	1.02696342 5	7.54072934 4	21.6986452 4	13.8308930 4	213.343172 7	0.90672727 4	16.5578502 1	225.603546 1	0.67929602 1	0.43537787 1
1936	Chinook_1	0.97827349 3	0.73844694 3	0.72240306 8	114.88	116.37	124.14	0.01960143 7	14146.7738 7	11.7911059 5	2.98317931 6	29.2663931 5	9.83296756 7	127.478759 8	0.97787916 7	1.07325973 5	8.05172981 3	20.5002663 2	11.1641019 2	289.969879 2	0.86192486 7	17.4787445 1	301.894287 1	0.79004501 8	0.57876086 8
1937	Chinook_1	0.95597935 6	0.68856304 7	0.65825205 8	123.12	124.97	132.24	0.01903997 4	12519.4749 3	9.90080227 2	4.29133842 9	20.5893911 3	10.5224773 4	52.1786438 1	0.93991005 4	0.76620845 8	8.28757363 6	19.5663375 8	12.3336221 4	165.318041 5	0.90321866 7	14.5206036 6	178.770828 2	0.75626027 3	0.51555154 3
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Columbia River System Operations Environmental Impact Statement
Appendix E: Fish, Aquatic Macroinvertebrates, and Aquatic Habitat

Year	Species	InRivSurvSNK	InRivSurvLCol	InRivSurv	MedDayLGR	MedDayConfl	MedDayBON	SAR	TotalReturn	meanGas	SNKTravelTime	SNKMigRate	SNKTemp	SNKFlow	SNKFSpill	SNKGas	LCTravelTime	LCMigRate	LCTemp	LCFlow	LCFSpill	LCGas	BonFlow	monte_q975	monte_q025
1943	Chinook_1	0.977807275	0.720409109	0.704421267	121.9	123.25	129.65	0.018855694	13268.75464	11.82366974	3.882913448	22.97603046	10.12936344	124.9120224	0.961201179	1.056078053	7.893754572	20.92175503	11.88482269	294.8545074	0.851883312	17.45827776	300.7654419	0.794905717	0.578625257
1944	Chinook_1	0.958182091	0.584174487	0.559745532	129.23	130.83	138.47	0.017632197	9860.711402	9.980652605	3.048504509	28.34612071	11.75212288	59.15698776	0.943910837	0.849004459	7.729481488	21.06412816	13.78422991	161.8312378	0.911280066	14.73135098	170.6989746	0.677200802	0.437793389
1945	Chinook_1	0.961709967	0.698320045	0.671581347	118.2	120.29	127.78	0.019407304	13021.48685	10.33911525	3.663500771	23.87253594	10.63175945	64.73920135	0.945817494	0.772329333	8.216576487	19.79774714	12.08190997	194.3174795	0.892609258	15.19070347	211.8741302	0.747974142	0.559338522
1946	Chinook_1	0.978327348	0.778163006	0.76129815	110.02	111.95	120.25	0.019438441	14786.13129	12.03391354	4.063319944	21.98405599	9.205426598	114.2905258	0.969034421	0.965983391	8.44511389	19.54885118	10.33722862	319.6123149	0.844072709	17.58940764	335.6716614	0.821566395	0.611653326
1947	Chinook_1	0.967744498	0.710414629	0.68750019	108.7	111.13	119.52	0.019229841	13208.69782	11.35111356	4.383506298	20.37900432	9.694306946	84.48561554	0.975447404	0.921551609	8.409847997	19.06180019	11.58595626	248.8662313	0.888183365	16.82047796	262.2990112	0.762848173	0.565651385
1948	Chinook_1	0.973659701	0.638393402	0.621577929	132.54	133.78	137.76	0.016823143	10447.70397	14.20151302	2.150860436	39.64016482	11.95383321	132.1752411	0.974315572	1.336288643	6.328112707	27.36218985	13.5940431	395.6791331	0.842406611	20.98513556	414.8632507	0.717074026	0.528242351
1949	Chinook_1	0.970768105	0.582433907	0.56540826	125.65	127	133.09	0.018226354	10297.73823	12.60760679	2.165617034	39.24898154	12.09289188	117.8052505	0.972261691	1.198187733	6.894232914	24.58375048	14.18464947	323.9129588	0.844444185	18.22808552	347.2767944	0.692479985	0.435473588
1950	Chinook_1	0.971485699	0.692744175	0.672991059	130.9	132.48	138.6	0.017894873	12030.36913	11.48146571	2.745291494	31.37176478	11.22142067	85.63347321	0.978779149	1.046961308	7.179582514	23.38387706	12.70776065	259.0284195	0.879111369	17.01640558	275.8941345	0.773534161	0.546245286
1951	Chinook_1	0.974348912	0.647404636	0.630798003	130.39	131.7	137.97	0.017436862	10987.56008	12.52026715	2.743834965	31.53960446	11.37215195	104.7436081	0.964410833	1.159157753	6.751477346	25.27377856	13.55122407	338.0545298	0.831213226	18.16790899	353.8452454	0.730723163	0.524860933
1952	Chinook_1	0.984914017	0.729560387	0.718554252	124.86	126.09	132.34	0.018666226	13399.88526	12.58974859	2.573674098	33.70973344	10.58706093	157.8141846	0.953981721	1.071937943	7.17498716	23.91044421	12.05127954	354.1391856	0.818267077	18.18291966	368.4886475	0.793534141	0.606813215
1953	Chinook_1	0.965057303	0.672311483	0.648819106	130.85	132.48	139.24	0.016383159	10617.97706	11.21481186	3.765216932	23.36934333	10.95955276	80.14260101	0.961151266	0.984882545	7.300484136	22.77671354	12.93923775	246.9138082	0.873731891	16.49672731	262.0638733	0.727191116	0.556801764
1954	Chinook_1	0.975067368	0.697619981	0.680226478	138.15	139.35	144.01	0.015388223	10456.92253	12.07644067	2.885284878	30.1524882	11.03332521	103.8382614	0.961036277	1.082496071	6.712480657	25.38815217	12.78124444	309.5106557	0.844716191	17.68726714	319.6470947	0.767049198	0.587949923
1955	Chinook_1	0.970502541	0.651422995	0.632207671	133.73	135.1	141.11	0.016729733	10565.51698	11.11413319	2.813577816	30.70988364	11.21977733	81.32626343	0.971830285	0.987962818	7.172431715	23.26792281	13.34560299	230.0126038	0.892495145	16.47750187	243.7009583	0.718668169	0.508501649
1956	Chinook_1	0.978907118	0.739157057	0.723566105	116.13	117.49	124.32	0.018423419	13317.13302	13.62485014	3.351969726	26.35002478	10.00577679	137.4758942	0.960739756	1.172539711	7.595436661	22.27061894	11.42792114	395.6449483	0.816176891	19.66749239	414.5856934	0.782100735	0.606681795
1957	Chinook_1	0.970518925	0.718765316	0.697575342	116.37	118.32	124.8	0.017359585	12096.44979	12.38880553	3.998136304	22.28043657	10.35209484	121.1076309	0.962962782	1.00532856	7.572331294	21.65192371	11.76366409	311.5152743	0.855042795	18.00007772	326.0296326	0.753678157	0.601122702
1958	Chinook_1	0.976549801	0.685469849	0.669395444	126.93	128.25	133.57	0.017807856	11912.10978	12.51533335	2.226948033	38.14290298	11.23929157	117.8062119	0.971467066	1.112685871	6.856097847	25.01687363	12.78115018	325.6503906	0.842806776	18.18177319	346.2767029	0.745298002	0.574911267
1959	Chinook_1	0.966063507	0.628228462	0.606908591	134.86	136.22	142.05	0.016035815	9723.258048	11.88345238	2.787673518	30.86775449	11.68436661	80.60951385	0.979920614	1.160819533	6.809950501	24.73887243	13.72037999	280.8362025	0.867863675	17.66130129	291.2876282	0.706110211	0.511639501
1960	Chinook_1	0.972011332	0.655921371	0.637563006	133.09	134.38	139.59	0.017229565	10973.53996	11.63357851	2.918840341	29.65684016	11.13532276	88.31979218	0.972487593	1.117083931	7.047677517	23.77567872	13.30161158	263.5530294	0.874884715	17.32555008	272.5137024	0.740988571	0.519493350
1961	Chinook_1	0.957605421	0.667466629	0.639169663	117.98	120.08	126.49	0.018629099	11895.72518	11.18995803	4.264121704	20.63997354	10.63119736	61.47111133	0.97028358	0.963421822	7.977113999	20.30908564	12.65578731	231.9804128	0.892112315	16.59412432	240.7607574	0.717530835	0.5350691
1962	Chinook_1	0.973974707	0.717702394	0.699023979	118.07	119.66	127.18	0.019531271	13638.40782	11.49822858	3.140833966	27.56120738	10.35104313	91.05131683	0.982871556	1.101163769	7.997104883	20.52092152	11.87810421	247.722379	0.888783524	17.20689106	253.6599731	0.770928052	0.562588262
1963	Chinook_1	0.959613413	0.64877624	0.622574382	117.46	119.44	126.01	0.018738843	11653.44721	10.47385754	4.165358879	21.25520022	10.71478386	67.68595886	0.958147526	0.837293533	8.213894986	19.5507835	12.68242375	195.0167262	0.906034023	15.46192161	204.4720001	0.706218712	0.522752942
1964	Chinook_1	0.972905328	0.632490434	0.615353313	133.17	134.65	141.03	0.016676129	10250.88735	11.49788894	2.501711577	34.29846607	11.45431366	89.87354431	0.97050966	1.014392376	6.780628607	25.12509191	13.84780587	265.4561717	0.871222963	16.94982274	281.4285889	0.741876206	0.479032731
1965	Chinook_1	0.960053676	0.54288143	0.521195313	143.99	144.66	144.81	0.013898757	7237.706731	12.33075823	2.055825211	41.42637728	13.21187	135.6701233	0.959948957	1.162129402	6.399116486	26.89596893	14.22004159	328.4667511	0.822900116	17.99584214	335.9306946	0.622498353	0.441484923
1966	Chinook_1	0.956909876	0.721898371	0.690791681	109.41	112.01	120.5	0.019250364	13284.38463	10.24880665	4.893348061	18.19707947	9.875900078	62.07195053	0.967522418	0.837686634	8.766036756	18.10680844	11.19332329	181.3747228	0.914555411	15.13791577	189.2084351	0.755255036	0.535748881
1967	Chinook_1	0.962973264	0.724758643	0.697923196	124.39	126.43	133.65	0.018677414	13022.89356	10.74979779	3.541137062	24.48726788	10.56953221	55.62074661	0.960273767	0.876155186	7.768562771	21.24020882	11.84402577	214.7318166	0.894409994	15.81732798	227.0217285	0.7771711929	0.570384326

Columbia River System Operations Environmental Impact Statement
Appendix E: Fish, Aquatic Macroinvertebrates, and Aquatic Habitat

Year	Species	InRivSurvSNK	InRivSurvLCol	InRivSurv	MedDayLGR	MedDayConfl	MedDayBON	SAR	TotalReturn	meanGas	SNKTravelTime	SNKMigRate	SNKTemp	SNKFlow	SNKFSpill	SNKGas	LCTravelTime	LCMigRate	LCTemp	LCFlow	LCFSpill	LCGas	BonFlow	monte_q975	monte_q025
1968	Chinook_1	0.92572220 4	0.44703051 7	0.41382607 6	139.35	140.51	142.24	0.01524625 3	6303.84775 7	10.6338006 8	2.57460667 9	33.0703916 2	14.4788536 1	69.1655929 6	0.95460217 5	0.95483808 5	7.00400575 3	23.3321682 3	15.1847381 6	214.927380 9	0.87819917 1	15.6905349 1	224.339675 9	0.56917708 3	0.29362662 6
1969	Chinook_1	0.97632927 7	0.69653048 2	0.68004310 2	115.81	117.37	124.37	0.01916477 5	13020.1600 8	12.1513072 1	3.52626261 9	24.9373552 1	10.1175577 2	111.293661 5	0.97122720 5	1.12894468 3	7.8536257 3	20.9968065 7	12.2836127 3	311.285298 7	0.84583408 6	17.8988097 5	318.103546 1	0.77859634 7	0.56215884 2
1970	Chinook_1	0.96726173 9	0.69953419 8	0.67663266 5	125.62	127.2	133.76	0.01722026 6	11640.9883 3	10.4780583 7	3.38984068 5	25.6792316 8	10.7439790 7	83.0363174 4	0.94694677 6	0.83658247 3	7.70823558 4	21.3703831 4	12.2672036 5	213.799324 7	0.87757594 4	15.3899297 7	222.422515 9	0.74773967 5	0.57986658 5
1971	Chinook_1	0.98129748 9	0.64902248 8	0.63688413 7	137.58	138.66	142.48	0.01560477 3	9930.32369 3	13.8198096 1	1.90231598 2	44.6293371 1	12.1676473 6	150.888952 6	0.95914487 8	1.24592962 3	5.90723916 1	30.3238591 4	13.7172827 7	416.663915 5	0.78840643 2	19.8069060 6	423.237152 1	0.74493131 7	0.54847190 7
1972	Chinook_1	0.97752877 5	0.65716924 3	0.64240184 5	125.02	126.46	131.73	0.01746353 4	11208.9189 8	13.3056804 1	2.48920340 8	34.3961762 7	11.3823295 6	118.989283 8	0.97531887 3	1.23809471 1	6.82364761 8	24.7045000 5	13.3394653 3	360.385645 5	0.83971363 3	19.5930519 1	361.699035 6	0.72589800 5	0.54319827 8
1973	Chinook_1	0.94351222 9	0.63183318 5	0.59614233 6	120.04	122.06	127.51	0.01705062 3	10153.8706 3	9.46119925 5	4.69752655 2	18.9562872 6	10.9139125 8	50.1257812 5	0.92574909 9	0.79250135 4	8.30456225 6	19.3701849 7	12.7421061 2	154.091855 4	0.88121652 6	13.9816103 3	160.485794 1	0.67316673 4	0.50988331 9
1974	Chinook_1	0.97701786 4	0.60921645 8	0.59521536 2	135.13	136.34	140.98	0.01584932 1	9426.21562 5	13.5822242 3	2.05652112 5	41.3516239 9	12.2967531 2	135.866748 3	0.95917326 2	1.25801334 4	6.20371633 8	28.2235673 9	14.1859048 2	395.822519 9	0.80662014 1	19.7346216 8	400.573028 6	0.69289576 5	0.48225376 5
1975	Chinook_1	0.97350636 5	0.61465269 9	0.59836831 5	144.93	146.21	150.03	0.01229713 4	7352.32227 3	12.4232342 9	2.06925161 9	41.0464178 7	12.3147733 7	125.243910 2	0.96855977 8	1.18886442 2	6.20867510 9	27.8858251 7	13.9720603 6	323.369313 6	0.83330161 4	18.1069547 3	330.573181 2	0.68703178 2	0.50739570 5
1976	Chinook_1	0.98204023 6	0.75131098 8	0.73781762 5	119.77	121.3	128.68	0.01935206 1	14264.8234 4	12.2853323 1	2.79513207 1	30.9320006 5	10.0582645 4	119.161488 3	0.97601574 7	1.15220670 7	7.62283268 6	22.0314085 1	11.5065752 7	311.000885 6	0.85152991 7	18.0288446 7	320.013946 5	0.81069164 2	0.59685545 2
1977	Chinook_1	0.92914996 7	0.54135445 7	0.50299947 5	129.1	130.89	135.98	0.01701115 1	8548.11370 1	9.27752731 5	3.88756885 4	22.3500989 3	12.6296892 2	37.7428772 3	0.93099814 7	0.79472041 1	8.08473890 3	19.8085405 2	14.0845775 6	137.163495 4	0.89920488 9	13.6209557 9	143.331161 5	0.61261112 2	0.39925126 5
1978	Chinook_1	0.96751549 7	0.75405799 9	0.7295628 5	108.01	110.61	119.26	0.01864715 5	13589.0646 6	11.2363468 2	5.34589410 6	16.9210645 9	9.31665554 7	87.2778991 7	0.97093659 6	0.92643346 8	8.57355345 8	18.6890385 4	10.8852165 5	235.975410 5	0.89012079 4	16.7439977 3	248.421218 9	0.78644454 5	0.58410753 3
1979	Chinook_1	0.95806960 1	0.75015101 5	0.71869688 4	110.87	113.29	121.75	0.01935744 8	13897.4542 3	10.2246870 3	5.19595393 5	17.2328296 2	9.52576541 9	58.9365760 8	0.94579581 9	0.73361043 9	8.85613413 2	18.1133051 4	10.8625607 5	184.081825 3	0.89816168 3	14.8930984 1	204.737091 1	0.78938988 6	0.53167100 4
1980	Chinook_1	0.97674757 4	0.64814200 3	0.63307112 9	135.89	137.2	142.9	0.01507635 5	9537.23430 7	12.2972869 2	2.19800787 4	38.7253614 5	11.6388105 4	109.622963 3	0.96008197 1	1.13229923 2	6.51848641 3	26.5625156 3	13.6876451 2	328.886530 6	0.83188614 2	18.0263551 1	336.525970 5	0.71920667 2	0.53858170 2
1981	Chinook_1	0.94412464	0.56816923	0.53642256 9	126.77	128.07	127.95	0.01638047 9	8777.72107 5	10.7168285 5	4.39307858 5	20.3376566 5	12.4481987	76.4164871 2	0.94524525 4	0.89437789 9	7.63243290 8	21.1506346 2	13.6243739 1	225.852363 6	0.87316352 1	15.6965381 3	235.778213 5	0.63512652 4	0.44916685 2
1982	Chinook_1	0.96981910 5	0.55271584 6	0.53603438 8	142.58	143.65	145.2	0.01396485 8	7479.66873 8	12.8470344 2	2.08869475 1	40.7210022 9	13.1060287 5	124.890267 9	0.96889203 8	1.22676076 9	6.17606740 4	27.9313210 5	14.6131084 8	348.453481 7	0.82541015 7	18.7208630 2	353.313781 7	0.67040330 5	0.41044263 3
1983	Chinook_1	0.96824452 3	0.65669411 9	0.63584048 3	121.57	123.1	127.96	0.01652347 5	10496.3796 4	11.6448721 5	3.36459614 3	26.0332053 9	11.1546169 3	99.0770172 1	0.97046107 1	1.03038835 5	7.45320666 6	22.0991361 2	12.9262379 7	276.194854 7	0.86184198 7	17.1475067 1	286.181274 4	0.70712671 3	0.55709967 1
1984	Chinook_1	0.97388408 5	0.62029345 1	0.60409392 5	128.69	130.07	135.29	0.01710577 4	10325.3982 4	11.7112649 8	2.09985531 9	40.4038380 1	12.0908594 1	123.510409 5	0.97842108 5	1.13032503 1	7.01059250 5	23.9322319 9	13.4698672 3	268.298431 4	0.87158779 3	17.4453384 1	272.639343 3	0.69840728 2	0.49295742
1985	Chinook_1	0.97307697 3	0.76082953 1	0.74034569 7	108.21	110.37	119.02	0.01882288 1	13921.8367 6	11.2721155 7	4.75815618 8	18.9251928 4	9.12359943 4	110.758459 5	0.96974425 3	0.98718738 6	8.71157497 9	18.4429880 6	10.6068062 8	245.433469 1	0.88667535 8	16.8983534 2	246.101928 7	0.80000528	0.59272572 5
1986	Chinook_1	0.96039827 5	0.62492921 4	0.60018093 9	121.95	123.23	125.95	0.01695547	10166.2590 5	11.4932370 2	3.95884242 7	22.4265430 3	11.1570488	104.379841 6	0.97082299	1.04217243 2	7.73801638 2	20.8883856 9	12.785405	253.753832 5	0.87742037 6	17.1226739 9	256.103363	0.67225002 2	0.51935269 4
1987	Chinook_1	0.93636682 2	0.58178142 2	0.54476082 2	117.21	118.81	125.06	0.01973777 3	10744.8148 7	11.2732947 6	3.34658630 2	25.7438531 8	12.1118684 8	56.6703369 1	0.97130821 9	1.00272836 7	7.87760265 9	20.5629259 1	13.4597002 7	242.421826 7	0.88468885 4	16.6717939 4	258.404937 7	0.64270465 2	0.44865573 4
1988	Chinook_1	0.95241487	0.74462649 7	0.70919334 8	107.39	110.15	118.73	0.01878023 5	13304.7673 8	10.2521612 8	6.37402510 6	14.4178121 8	9.04733791 4	58.1117736 8	0.94819856 9	0.73808713 9	8.95306260 1	17.7444977 9	10.6896541 9	185.511177 1	0.91022508 3	15.1571939	193.584152 2	0.76938751 3	0.55108852 8
1989	Chinook_1	0.96821140 5	0.58585926 4	0.56723562 1	140.49	141.9	146.48	0.01490250 2	8446.86975 5	11.5800671 6	2.49593351 8	34.0845975	11.6666626	79.9286621 1	0.98265061 4	1.16535930 6	6.89633291 2	24.3560293 5	14.0586660 7	244.255271 9	0.89266518 8	17.3558120 7	247.267929	0.69056377 1	0.44810893 1
1990	Chinook_1	0.93974725	0.46811876 1	0.43991331 8	130.16	131.6	136.36	0.01821392	8005.87878 3	11.1882996 6	2.52339644 7	33.6262952 7	13.668116	63.6682777 4	0.98048585 7	1.13696289 1	7.20640253 3	22.6330215 9	15.0197045	216.415311 2	0.90769251 2	16.8166538 9	215.300796 5	0.62046543 5	0.29718825 8
1991	Chinook_1	0.95521144 7	0.65044915 5	0.62131647 8	122.87	124.86	129.61	0.01769818 3	10984.9146 3	11.3000588 8	4.13899523	21.3719807 1	10.9657318 1	59.6423492 4	0.96726906 3	0.98813676 8	7.62884602	21.4356315 4	12.9016221 4	247.154047 6	0.88275904 5	16.7519148 2	249.472473 1	0.70423478 3	0.54210335 1
1992	Chinook_1	0.92597682 6	0.56462568 9	0.52283030 4	120.46	122.09	127.06	0.01920389 4	10029.9439 3	10.4065415 5	3.74903594	23.2525874 9	12.7055984 5	49.1496666	0.95998457 7	0.85124244 7	8.02691532 7	19.9012607 2	13.5349268 9	189.379201	0.90809837	15.4543151 9	195.218246 5	0.63387257 9	0.43165712 1

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Appendix E: Fish, Aquatic Macroinvertebrates, and Aquatic Habitat

Year	Species	InRivSurvSNK	InRivSurvLCol	InRivSurv	MedDayLGR	MedDayConfl	MedDayBON	SAR	TotalReturn	meanGas	SNKTravelTime	SNKMigRate	SNKTemp	SNKFlow	SNKFSpill	SNKGas	LCTravelTime	LCMigRate	LCTemp	LCFlow	LCFSpill	LCGas	BonFlow	monte_q975	monte_q025
1993	Chinook_1	0.97016193 3	0.73435558 2	0.71244383 1	120.1	121.86	129.58	0.01953849 2	13907.8291 2	10.6113844 8	3.19607148 3	27.0202187	10.3873720 2	75.9868850 7	0.94928903 6	0.73003745 1	8.11764058 5	20.2685799 7	11.4527966 2	209.252749 1	0.89357814 2	15.5158739 9	225.954956 1	0.79019824 8	0.57052639 1
1994	Chinook_1	0.93349560 4	0.50693571 6	0.47322226 2	127.14	128.57	134.26	0.01862353	8805.60624 3	11.1050381 3	2.63622938 8	32.2706096 1	12.7212406 2	59.8409637 5	0.97614052 3	1.06259260 2	7.39828447 3	22.1079258 2	14.4030017 9	210.763608 3	0.90845873	16.6022842 7	219.991226 2	0.60639610 7	0.37205572
1995	Chinook_1	0.96573207 8	0.65572833 1	0.63325788 4	126.87	128.34	133.66	0.01658243 6	10490.3727 2	11.0437794 8	3.83677748 6	23.1247752 8	11.0135335 9	91.8657714 8	0.96252572 5	0.96356706 6	7.51744000 6	21.7696998 6	12.9286100 1	236.995979 3	0.88235233 2	16.3157293 1	246.243164 1	0.71203436 1	0.54321406 9
1996	Chinook_1	0.95604399 5	0.54659838 6	0.52257210 5	140.37	141.1	142.92	0.01380115 1	7205.63348 2	12.4121695 6	2.17553972 5	39.1153006 8	13.6672536 8	122.183993 5	0.9589064	1.1641078	6.41589359 9	26.6707396 1	14.5191723 5	331.406041 5	0.82507385 8	18.0436576 2	342.317443 8	0.64692922 2	0.41169595 5
1997	Chinook_1	0.97303879 4	0.58071370 6	0.56505696 4	133.3	134.21	137.06	0.01626973 1	9186.25860 8	15.1929568 9	1.94156251 8	43.8138853 5	12.5410562 5	161.848419 2	0.96157492 4	1.40382032 4	6.01483380 8	29.2857876 4	14.2840914 7	457.788177 5	0.80032715 2	22.0417356 5	466.292541 5	0.66851121 9	0.47043126 9
1998	Chinook_1	0.96652854 6	0.68559334	0.66264553 4	115.22	117.09	124.26	0.01909073 1	12637.8494 7	11.4159259 1	4.13511013 2	21.4658772 3	10.3977863 3	86.9398651 1	0.95530041 5	0.87652874	7.95710452 6	20.5442729 3	12.432947	268.124646 5	0.86387025 3	16.5730965 9	286.857086 2	0.73896896 7	0.55474975 4
1999	Chinook_1	0.97224345 4	0.66186588 6	0.64349477 5	119.59	121.03	127.36	0.01929674 7	12406.4321 9	11.6779873 4	3.43652610 5	25.572545	10.7358583 5	99.8938049 3	0.97105590 1	1.05236082 1	7.88878790 3	20.7406725 7	12.8094995 8	275.495605 5	0.86890509 7	17.3753649 4	280.284606 9	0.74571285 5	0.53478710 3
2000	Chinook_1	0.95189486 5	0.51280803	0.48813933 1	130.52	131.63	135.15	0.01789482 6	8728.45792	11.6889743 1	2.31710755 1	36.7317035 8	12.6304359 4	87.4039749 1	0.98240479 2	1.20611457 8	7.08113159 2	23.3402125	14.3403007 2	250.751398 7	0.88776683 8	17.5392533 9	258.467651 4	0.61887990 9	0.38892726 4
2001	Chinook_1	0.94462122 9	0.70098253 9	0.66216298 7	108.95	112.1	120.91	0.01923469 3	12724.6941 6	9.01023263 6	6.26378150 3	14.4551842 7	9.49088268 3	38.4189926 1	0.89730253 2	0.62290940 3	9.19450821	17.3447422 5	11.5844229 1	133.103969 6	0.88307726 4	13.0493942 1	146.446472 2	0.74199212 2	0.53217622 2
2002	Chinook_1	0.96822305 5	0.70445013 7	0.68206486 4	119.18	121.02	128.02	0.01908543 3	13003.5973	11.3940654 8	3.35388048	25.8650851 2	10.4529851 9	70.8256652 8	0.97990225 6	1.06020956	7.94003916 5	20.5624879 8	12.0014362 3	235.702662 2	0.89751988 6	17.0758776 7	243.191482 5	0.76362985 1	0.56644858 9
2003	Chinook_1	0.96314653 1	0.62889359	0.60571667 9	129.1	130.74	137.64	0.01707871 3	10334.7638 3	11.4103021 6	3.07202166 3	28.1840134 4	11.4694406 5	75.6530715 9	0.97412800 8	1.03736362 5	7.34110768 9	22.4217174 1	13.4722342 5	235.159581 5	0.89445573 1	16.8814603 5	253.438629 2	0.70130505 2	0.49896710 4
2004	Chinook_1	0.95722382 3	0.73985632 2	0.70820809 6	105.75	109	117.77	0.01864667	13192.0044 1	10.5892564 9	6.20958787 9	14.6976431 8	8.94419002 5	60.7537063 6	0.96165866 9	0.80678825 4	8.88664914 7	17.8406587 7	10.8816657 1	199.912862 1	0.90691825 7	15.6432336 2	215.912597 7	0.78076274 1	0.55798864 4
2005	Chinook_1	0.95226126 4	0.59264786 9	0.56435560 9	122.11	123.88	129.6	0.01870086	10542.6516 6	10.6529376 2	3.51030616 5	24.8776581 2	12.0203971 9	65.8543907 2	0.96557372 8	0.93745594	7.84960897 3	20.5294774 2	13.6566395 8	201.212023 4	0.90369658 7	15.7633711 5	210.776336 7	0.66801995 7	0.45717195 4
2006	Chinook_1	0.98184829 3	0.73561368	0.72226103 5	121.01	122.31	129.62	0.01951933 5	14083.6264 1	11.9705764 6	2.66206442 6	32.5123664 4	10.3262306 2	127.798349	0.97166190 1	1.13365545 3	7.67826074 4	21.7554067 9	11.7519747 4	292.541132 6	0.86093972 1	17.7868072 2	297.541168 2	0.80621954 8	0.57767691 5
2007	Chinook_1	0.95403276 7	0.61887696 2	0.5904289	120.3	121.88	128.03	0.01885572	11120.4844 7	11.4309561 9	3.74606287 5	23.4897271	11.7589630 1	67.2634368 9	0.97868803 7	1.08184461 6	7.75677692 9	20.8595877 8	13.3870029 4	240.248423 3	0.89316283 7	17.0964220 4	249.585861 2	0.69232368 5	0.48418830 8
2008	Chinook_1	0.94545494	0.73964286 7	0.69929900 3	106.26	109.54	118.12	0.01840504 7	12859.3012 3	9.91110927 7	7.25730519 7	12.9407935 2	9.41007671 4	60.0873428 3	0.92754094	0.67335357 7	8.84291730 1	17.9455052 4	10.8760059 7	180.678118 4	0.90320461	14.4015723 1	190.991104 1	0.75700633 8	0.56277207 6

6 Table 4-5. Snake River MO1, MO2, MO4, Steelhead Raw Data

Year	Species	InRivSurvSNK	InRivSurvLCol	InRivSurv	ProportionTransported	MedDayLGR	MedDayConfl	MedDayBONinriv	MedDayBONtrans	meanTravelTime	meanMigRate	meanTemp	meanFlow	meanFSpill	meanGas	SNKTravelTime	SNKMigRate	SNKTemp	SNKFlow	SNKFSpill	SNKGas	LCTravelTime	LCMigRate	LCTemp	LCFlow	LCFSpill	LCGas	BonFlow	propBONinriv	propBONtrans	JDAInRivSurv	DeschInRivSurv	BONInRivSurv	JDATime	JDAMigRate	JDATemp	JDAFSpill	JDAGas	DESTTime	DESMigRate	DESTemp	DESFSpill	DESGas	BONTTime	BONMigRate	BONTemp	BONFSpill	BONGas	monte_q975	monte_q025					
SCN NAA-RESSIM																																																							
1929	Steelhead	0.6988 79773	0.5630 74481	0.3935 21366	0.3932 1841	126.8	133	140.1 4	144.2 6	21.90 23343 3	27.17 35563 8	12.72 40446 6	143.8 28058	0.886 05604	12.98 49142 7	12.13 21711 6	10.35 74126 2	11.30 35272 6	65.41 97738 6	0.810 02048 3	10.96 78754 8	7.821 26944 5	22.00 89359 1	13.24 40247 5	178.9 99338 8	0.892 44689 5	13.35 96039 6	191.2 03689 6	0.404 29885	0.595 70115	0.631 73437 6	0.817 46928 4	0.860 92959 8	5.877 45969 7	23.06 94804 6	13.43 16112 5	0.906 30172 5	14.81 30975 7	2.061 10229 3	19.40 85354 4	13.63 14846 7	0.907 12068 5	14.92 61735 3	1.599 54693 2	15.90 21452 4	13.77 81486 5	0.924 42065 5	15.89 99347 7	0.495 92268 8	0.283 82907 8					
1930	Steelhead	0.5062 9952	0.4440 75889	0.2248 35409	0.3163 07638	141.5 6	141.0 4	142.2 9	146.7 8	18.22 33821 4	28.69 25871 4	14.86 90930 8	137.7 09089 8	0.883 49742 1	12.62 36504 8	8.967 72906 2	12.79 45215	13.40 68780 9	63.37 88658 1	0.809 17223 7	10.36 54504 8	7.332 89545	23.07 91098 6	15.40 26385 9	176.4 80178 8	0.887 18400 4	13.13 78978 1	181.6 88644 4	0.367 84286 4	0.632 15713	0.520 64944 5	0.761 36778 4	0.815 24950 9	5.601 35751 2	23.94 40813	15.56 43119 8	0.905 53617 5	14.66 4291	2.014 44017 1	19.91 10161 4	15.71 71297 1	0.908 58928 4	14.89 04959 4	1.567 67284 8	16.21 85925 2	15.88 15083 5	0.927 55156 8	15.85 76936 7	0.321 93029 7	0.150 56093 4					

Columbia River System Operations Environmental Impact Statement
Appendix E: Fish, Aquatic Macroinvertebrates, and Aquatic Habitat

Year	Species	InRivSurvSNK	InRivSurvLCol	InRivSurv	ProportionTransported	MedDayLGR	MedDayConfl	MedDayBONinriv	MedDayBONtrans	meanTravelTime	meanMigRate	meanTemp	meanFlow	meanFSpill	meanGas	SNKTravelTime	SNKMigRate	SNKTemp	SNKFlow	SNKFSpill	SNKGas	LCTravelTime	LCMigRate	LCTemp	LCFlow	LCFSpill	LCGas	BonFlow	propBONinriv	propBONtrans	JDAInRivSurv	DeschInRivSurv	BONinRivSurv	JDATTime	JDAMigRate	JDATemp	JDAFSpill	JDAGas	DESTTime	DESMigRate	DESTemp	DESFSpill	DESGas	BONTTime	BONMigRate	BONTemp	BONFSpill	BONGas	monte_q975	monte_q025			
1931	Steelhead	0.5337 79955	0.4177 58463	0.2229 91094	0.3421 26036	139.5 7	144.0 5	147.1	142.1 5	17.58 33078 4	29.10 84017 9	15.02 54407 6	133.6 92064	0.894 38899 1	12.77 56560 2	8.616 51235 1	13.23 37858	13.40 51096	58.06 99752 8	0.833 84350 5	10.76 99585	7.039 97705	23.75 23313 6	15.92 56215 1	172.8 70183 3	0.892 03803 7	13.16 50384 3	177.0 3125	0.335 46147 7	0.664 53852 3	0.493 07074 1	0.743 18427 5	0.799 95776 5	5.435 97684 8	24.45 37083 9	16.07 90247	0.909 09118 7	14.75 38055 5	1.972 63209 5	20.35 19759 6	16.10 00057 9	0.911 04555 1	14.93 36554 2	1.536 77655 8	16.53 83516 2	16.07 34028 8	0.930 58288 1	15.86 91144	0.349 19869	0.134 58528 6			
1932	Steelhead	0.7823 43057	0.6519 46403	0.5100 45742	0.4109 33216	118.1 9	124.0 2	130.2 3	136.3 9	18.39 36828 7	30.12 59284 5	11.81 11184 7	228.6 62163 3	0.849 97172	14.85 81437 7	9.796 53970 9	12.65 67126 4	10.36 08882 9	94.63 32687 4	0.747 20302 8	12.02 86380 8	6.619 74018 1	27.45 30766 9	12.19 04559 1	291.3 94093 8	0.860 59859 4	15.04 00075 1	302.3 26293 9	0.444 80563 1	0.555 19436 9	0.710 41596 9	0.856 24189 9	4.942 34376 1	29.07 18223 5	12.38 21476 7	0.871 47168	16.90 57195 8	1.646 72877 6	24.21 40084	12.69 61511	0.884 64176 7	1.275 71585 6	1.275 57372 3	19.89 27033 4	12.97 64142	0.892 58569 5	18.83 28180 3	0.604 53014 2	0.378 44417 2				
1933	Steelhead	0.7159 58744	0.5784 23573	0.4141 27415	0.2826 61651	126.6 7	129.9 2	135.5 6	147.0 3	19.03 00035 2	29.65 97274 4	13.15 24721 6	200.2 11920 6	0.878 38698 3	14.19 19585 3	10.40 82679 4	11.83 37571	11.44 51465 6	71.10 92102 1	0.817 84363 2	11.38 66561 9	6.675 31634 1	26.53 81228 5	13.77 77799	261.1 51845 3	0.868 41615	14.51 43272 9	273.0 31402 6	0.540 99934 7	0.459 00065 3	0.646 25500 3	0.827 04889 7	0.868 74033 6	5.021 83307	27.91 78334 7	13.96 12089 2	0.883 01162 7	16.39 80972 3	1.711 93692 8	23.32 07027 5	14.21 83380 1	12.69 67885 7	0.884 75021 4	1.275 67794 3	1.275 57372 3	19.89 29801 8	12.97 59223 9	0.892 86260 8	18.83 79644 6	0.604 65757 8	0.378 69863 3		
1934	Steelhead	0.4469 03919	0.4848 79791	0.2166 94679	0.1687 25911	140.8 2	139.3 7	138.8	142.1 3	15.58 04299 1	31.86 64479 7	15.14 86223 8	205.1 27100 6	0.893 15815 9	14.39 64231 4	7.692 37845 4	14.39 11150 2	14.27 97733 3	58.16 24679 6	0.863 22833 3	11.84 21873 1	5.948 18914 7	29.44 70509 7	15.46 12817	285.7 69455	0.864 67884	14.78 64186	291.7 18719 5	0.572 32988	0.427 67012	0.562 24301 9	0.790 86522 7	0.840 34569 5	4.564 48949 1	30.64 27113	15.54 22626 5	0.870 02699	16.79 94453	1.582 96356	25.28 28136 1	15.61 43344 2	0.883 33189 5	17.12 81331	1.230 54233 9	20.62 26233 9	15.71 92935 9	0.890 38541	18.15 50378	0.297 60417	0.146 52536 9			
1935	Steelhead	0.7059 3546	0.5561 11367	0.3925 78733	0.3046 79173	125.4 1	131.3 9	137.9 7	139.0 8	18.65 44450 4	29.35 39687 3	13.29 32870 7	177.8 83688	0.880 41182 5	13.34 14890	9.885 12871	12.13 55667	11.58 47375 9	68.27 27996 8	0.815 41773	10.67 86218 6	6.819 06057	25.63 76915	14.03 37505	232.8 59759	0.874 77981	13.86 77451 6	244.0 79772	0.500 53631	0.499 46368	0.625 90337	0.817 64813	0.861 32150	5.163 59151	26.84 20275	14.20 09788	0.890 61077	15.67 92527	1.786 92527	22.36 28779	14.37 72411	0.893 83308	16.03 12849	1.386 91647	18.30 10272	14.50 80227	0.904 48865	17.06 72416	0.500 69622	0.273 75662			
1936	Steelhead	0.6943 89721	0.6530 12429	0.4534 45118	0.3620 63537	118.6 6	118.5 9	124.4 7	140.2 8	17.98 63497 5	30.82 31366	11.79 67545	242.0 08281	0.814 23922	15.48 24007	9.366 13653	14.37 48559	10.84 24442	119.4 19911	0.646 90499	13.01 71760	6.639 20706	27.70 84458	11.79 60588	303.4 47916	0.860 80451	15.63 66717	313.9 92431	0.476 56053	0.523 43946	0.711 02302	0.859 12183	0.895 19252	4.908 58596	29.49 72973	12.01 17488	0.866 02543	17.24 08103	1.627 23057	24.51 92527	12.32 19109	12.32 09530	12.65 00305	0.894 81860	0.894 82328	17.78 85479	1.260 5254	20.12 5254	12.65 12231	0.894 70103	19.09 31358	0.527 26808	0.370 72781
1937	Steelhead	0.7268 60753	0.5733 38268	0.4167 37086	0.2729 50876	119.5	129.0 4	136.0 4	134.2 3	23.54 51969 5	26.84 60208 9	12.40 98580	143.7 30476	0.886 80580	12.85 30743	13.74 43874	9.469 94815	10.76 11631	56.47 23800	0.819 69782	10.67 48910	7.832 10190	22.31 31952	13.06 56313	186.2 27216	0.886 13236	14.181	199.6 43615	0.554 16827	0.445 83172	0.641 22034	0.820 72363	0.863 14807	5.840 96201	23.51 40142	13.26 48418	0.902 96115	14.81 82458	4.563 45638	19.74 98353	13.50 81860	0.904 37922	15.01 76404	1.569 13619	16.20 37118	13.67 85111	0.920 70740	16.05 19838	0.521 65757	0.295 48451			
1938	Steelhead	0.7745 02212	0.6521 65367	0.5051 0352	0.3944 01063	119.4 1	120.3 4	125.2 6	139.2 5	16.20 60620 9	32.01 26397 9	12.01 58742	247.0 62387	0.827 11319	15.54 33586	8.005 19377	15.82 76690	10.81 77860	114.7 13398	0.683 94938	12.86 04278	6.222 96804	29.22 16973	12.25 07673	320.3 70727	0.859 97353	15.83 81130	332.3 37829	0.460 31221	0.539 68778	0.710 29071	0.856 92908	0.893 24448	4.667 15497	30.89 15379	12.42 02608	0.861 04563	17.64 01609	1.552 51636	25.70 81755	12.70 82729	0.888 42986	17.89 78122	1.203 59890	21.08 69266	12.98 92206	0.901 40378	19.10 37769	0.588 80561	0.392 06397			
1939	Steelhead	0.5539 49358	0.5127 36095	0.2840 29831	0.3743 74097	138.6 2	140.6 2	141.5 9	141.0 6	17.49 40033	29.70 37616 4	13.62 07082	173.4 43774	0.867 33582	13.36 70870	8.708 20048	13.52 03216	12.75 23534	74.46 92749	0.784 65335	11.10 89845	6.831 57804	25.36 74673	14.01 74034	224.3 39909	0.869 90581	13.76 36609	229.1 52557	0.360 96365	0.639 03634	0.584 72401	0.798 55336	0.846 68169	5.192 41157	26.47 87397	14.13 49668	0.889 18654	15.45 83595	1.826 48	21.94 08290	14.15 47082	0.893 72009	15.87 36651	1.421 25994	17.86 27180	14.19 12484	0.905 9003	16.89 16473	0.378 38774	0.201 26279			
1940	Steelhead	0.6369 07744	0.5553 94416	0.3537 35005	0.3428 67796	125.0 6	125.5	130.6 1	143.2 5	18.45 98550 8	29.31 61010 2	13.31 51681	182.9 44674	0.852 40038	13.21 42259	9.460 17418	12.75 96904	11.71 30569	81.18 11264	0.746 95999	10.49 41438	7.048 03224	25.05 34396	13.76 64849	234.6 99460	0.866 46786	13.83 32487	241.7 81433	0.436 34226	0.563 65773	0.625 67154	0.817 62766	0.861 53103	5.299 64800	26.34 94177	13.95 32835	0.885 97099	15.50 61735	1.828 49877	21.86 56361	14.23 73466	0.890 31950	15.89 13437	1.419 73232	17.88 17456	17.88 91617	14.51 11872	0.901 98191	16.92 66995	0.259 51868			
1941	Steelhead	0.6177 41454	0.4990 14032	0.3082 61654	0.2912 95682	127.7 9	130.5 5	136.1 4	141.8 2	18.41 40093 1	28.71 27232 7	14.25 07707	142.8 31965	0.894 04590	12.86 97346	9.230 86466	12.46 22503	12.92 06687	23213	0.837 37748	10.82 70683	7.246 75376	23.63 52664	14.76 87687	187.0 72532	0.888 29277	13.21 97998	194.7 94006	0.463 43374	0.536 56625	0.574 97403	0.789 52106	0.837 95262	5.515 4223	24.61 10218	14.90 99891	0.904 63347	14.82 73860	1.953 34129	20.51 58934	15.08 06592	0.905 56399	15.04 51444	1.519 32461	16.72 49559	15.21 08397	0.922 10364	16.00 09388	0.411 83491	0.207 16810			
1942	Steelhead	0.7747 51882	0.6336 15452	0.4908 94763	0.3023 45551	116.2 1	122.0 3	129.0 6	143.7	19.95 20716	28.15 74847 9	11.58 97120	175.0 51362	0.861 76469	13.32 91397	10.38 81378	11.97 63364	10.30 03614	83.84 54269	0.758 68276	10.63 94235	7.588 67732	23.39 24242	11.92 01568	219.0 44919	0.878 54894	13.88 54026	224.2 71911	0.552 79016	0.447 20983	0.693 50021	0.847 41315	0.885 14315	5.654 05837	24.71 97932	12.14 21785	0.895 02888	15.46 76265	1.949 30306	20.53 74716	12.41 23611	0.899 32707	15.81 91591	1.514 75439	16.77 45228	12.64 44597	0.913 09067	16.91 75038	0.584 45200	0.371 92206			
1943	Steelhead	0.7679 13647	0.6242 52651	0.4793 7213	0.4614 98489	126.4 6	128.1	131	133.7 6	15.88 76839 5	31.66 54346	12.26 35169	232.3 70114	0.828 17611	15.38 00121	7.548 30232	15.93 41232	10.93 57130	114.4 32005	0.680 68014	13.36 74551	6.364 94939	28.26 59693	12.66 40489	295.2 80914	0.865 17773	15.41 44045	311.8 17840	0.379 88504	0.620 11495	0.685 58934	0.845 87618	0.883 39030	4.790 43640	29.79 43640	12.84 87827	0.870 75257	17.11 72954	1.602 52309	24.88 94611	13.09 14764	0.890 79640	17.44 66325	1.241 66325	20.43 42075	13.31 505	0.902 63542	18.61 89041	0.578 67745	0.363 21648			
1944	Steelhead	0.6981 22384	0.5173 34014	0.3611 62455	0.2715 42357	120.5 8	129.9 6	137.3 3	137.8	22.67 60824 2	26.91 61846 2	13.17 01551	129.1 79159	0.900 46665	12.81 25802	12.92 46244	9.792 69147	11.17 35811	55.05 76919	0.845 96052	11.05 70484	7.799 73352	21.92 66867	14.09 40353	165.8 90762	0.896 12225	13.09 68793	175.5 67565	0.5																								

Columbia River System Operations Environmental Impact Statement
Appendix E: Fish, Aquatic Macroinvertebrates, and Aquatic Habitat

Year	Species	InRivSurvSNK	InRivSurvLCol	InRivSurv	ProportionTransported	MedDayLGR	MedDayConfl	MedDayBONinriv	MedDayBONtrans	meanTravelTime	meanMigRate	meanTemp	meanFlow	meanFSpill	meanGas	SNKTravelTime	SNKMigRate	SNKTemp	SNKFlow	SNKFSpill	SNKGas	LCTravelTime	LCMigRate	LCTemp	LCFlow	LCFSpill	LCGas	BonFlow	propBONinriv	propBONtrans	JDAInRivSurv	DeschInRivSurv	BONinRivSurv	JDATTime	JDAMigRate	JDATemp	JDAFSpill	JDAGas	DESTTime	DESMigRate	DESTemp	DESFSpill	DESGas	BONTTime	BONMigRate	BONTemp	BONFSpill	BONGas	monte_q975	monte_q025	
1949	Steelhead	0.7896 73617	0.6308 41149	0.4981 58611	0.4129 27839	117.7 3	120.4 6	126.3 3	135.9	16.77 92820 8	31.49 00039 5	12.21 74545	254.8 94928	0.822 11406 7	16.03 42067	8.399 12813 2	15.41 57846 2	10.35 67325 6	124.1 38861 1	0.666 75529 5	13.33 47869 9	6.407 18966	28.26 43105 9	12.78 07498	313.9 00014 2	0.862 63663 6	16.05 22932 2	323.0 88195 8	0.436 98368 8	0.563 01631 2	0.690 44887 1	0.845 95176 8	0.883 70508 4	4.797 41626 2	29.88 26048 5	13.01 94358 8	0.867 40704 8	17.78 63950 3	1.592 62394 2	25.02 93210 6	13.39 21947 5	0.888 97750 8	18.40 92760 1	1.233 24852 4	20.57 71838 9	13.69 56067 1	0.897 81865 5	19.97 90344 2	0.593 30884 3	0.391 67893 9	
1950	Steelhead	0.7662 19902	0.6395 96166	0.4900 71312	0.3641 90496	123.2 7	127.1 2	133.4	138.9	18.76 17293 1	29.41 58723 1	11.79 27146	205.4 22538 2	0.851 20710 3	14.20 13140 7	9.809 83761 7	12.77 58417 1	10.55 93029 2	92.21 80435 2	11.60 11795 3	6.975 89626 9	25.67 45014 4	12.12 17379 6	260.6 80150 3	0.867 71838 9	14.52 98958 6	272.8 29254 2	0.485 38799 5	0.514 61200 5	0.699 33941 5	0.852 15240 4	0.889 46226 4	5.214 1954	27.12 27713 2	12.31 28917 7	0.880 49796 8	16.23 91750 3	1.766 51954 7	22.59 99100 4	12.55 27019 5	0.889 67742 5	16.70 75265 2	1.369 88416 3	18.52 79565 8	12.75 99295 6	0.898 92905 6	17.89 23331 4	0.580 26993 9			
1951	Steelhead	0.7629 40361	0.6210 11048	0.4737 94393	0.3831 88102	120.9 4	123.4 4	128.7 7	135.0	16.59 04683 5	31.55 31338 3	12.56 47593 2	244.7 50339	0.847 93497	15.49 33521 4	8.379 72418 2	14.56 23959 4	11.00 27395 2	100.9 37027	0.741 51839	12.66 58992 8	6.237 93014 9	29.12 06544 5	13.05 99254	316.7 81779	0.860 58311 7	15.63 25904 5	328.8 23303 2	0.457 8386	0.542 1614	0.683 23234	0.845 48880 9	0.883 88613 1	4.683 77003 1	30.76 58465 5	13.24 72896 6	0.863 46267 5	17.59 65288 2	1.554 54385 3	25.65 59595	13.52 30334 6	0.886 93555 2	18.10 12080 5	1.204 30681 1	21.07 44443 3	13.76 42822 3	0.897 40386 6	19.44 68183 5	0.571 68478 3	0.357 90924 8	
1952	Steelhead	0.8142 77512	0.6960 22213	0.5667 55236	0.5686 67503	119.9 2	120.1 4	125.6 4	134.9	14.78 50943 4	33.56 13118 3	11.19 57998 2	289.0 93098 3	0.786 87868 8	17.76 09742	6.708 86500 5	19.13 72418 4	10.14 09431 5	162.6 86633 3	0.574 49404	16.20 24078	6.087 52509 2	30.26 11194	11.31 00264 8	354.1 78110 8	0.857 30557 6	17.27 71177 9	362.7 93212	0.316 92901	0.683 07098	0.746 03700	0.873 01866	0.906 16811 6	4.539 64241 6	32.11 74569	11.53 39607	0.852 31488	18.80 11974	1.482 36810	26.90 82261 1	11.83 66699	0.892 92045	19.10 23966	11.83 24845	1.148 24845	22.11 30382	12.12 68844	0.907 63434	20.59 57250	0.647 36060	0.454 51203
1953	Steelhead	0.7600 17113	0.5891 66992	0.4477 76996	0.3894 16475	122.4 4	126.4 2	132.9 8	145.3	17.67 83006 5	30.61 89892 2	12.84 68962 4	215.0 28571	0.855 24918 4	14.63 62432	9.207 74811	13.62 14800	11.00 58301	91.90 33096	0.754 66400	11.87 42031	6.524 86959	27.27 42094	13.65 20992	272.7 43540	0.866 69523	14.97 49641	284.2 64343	0.438 04594	0.561 95405	0.655 38786	0.831 15978	0.872 02899	4.908 82590	28.71 01377	13.83 62123	0.879 75045	16.71 68256	1.662 48892	24.00 95066	14.05 68691	0.889 40864	17.27 10984	1.289 11115	19.68 37483	14.21 13871	0.898 32747	18.47 92633	0.549 11515	0.318 13659	
1954	Steelhead	0.7882 94942	0.6579 81144	0.5186 83208	0.3009 45807	112.7 8	120.3 7	127.6 7	137.3	21.09 85241	28.39 41111	11.21 68712	205.4 02148	0.858 98347	14.19 94122	11.86 03992	11.15 11825	9.846 81091	87.35 54565	0.761 35958	11.22 04500	7.251 24851	24.82 07467	11.58 49491	257.5 56704	0.869 82854	14.59 44273	264.8 38836	0.568 48034	0.431 51965	0.714 90430	0.858 29571	0.894 34304	5.388 36661	26.29 85022	11.80 05373	0.884 40115	16.30 95357	1.821 0418	21.92 69034	12.07 58482	0.893 6252	16.84 28061	1.412 21005	17.97 60290	12.30 31415	0.904 79195	18.16 76416	0.606 94134	0.415 41795	
1955	Steelhead	0.7543 2654	0.6030 66812	0.4549 09302	0.4151 17633	121.7 4	127.5 9	134.3 5	136.2	19.49 23478 6	28.81 49158 6	12.37 28775 3	180.1 16585	0.870 70184	13.53 08866	10.35 00512	12.09 10888	10.88 97392	77.30 34028	0.785 74416	10.85 00145	7.175 56643	24.64 78224	12.91 03665	229.8 62286	0.876 85113	14.08 90431	242.8 71063	0.413 39452	0.586 60547	0.667 28559	0.835 13858	0.875 10464	5.366 23370	25.98 78094	13.11 01377	0.891 94704	15.71 17704	1.836 39040	21.74 34990	13.36 40718	0.896 28732	16.08 04869	1.424 03960	17.82 37483	13.55 36661	0.908 12170	17.16 85681	0.558 11522	0.332 39136	
1956	Steelhead	0.7949 63964	0.6859 93897	0.5453 40427	0.4771 4423	126.0 9	123.2 1	128.0 6	140.6	14.72 69093	34.06 47557	11.77 19556	320.3 23787	0.827 17617	19.11 76227	7.222 83211	17.55 36592	10.64 82616	144.1 39428	0.686 45858	15.66 43161	5.529 13241	32.52 32671	11.98 75222	413.4 93133	0.858 02928	19.89 67065	429.0 84594	0.394 49909	0.605 50090	0.737 59642	0.871 78434	0.914 32170	4.151 39394	34.31 38619	12.18 71641	0.850 97893	21.97 69073	1.343 07780	29.68 89640	12.44 75278	0.908 60422	21.92 10815	1.039 03495	24.47 88712	12.69 35362	0.918 66216	22.91 71037	0.629 42821	0.448 12287	
1957	Steelhead	0.7891 33397	0.6692 53891	0.5281 30597	0.4444 06001	117.3 8	120.4 8	126.9 1	142.0	17.80 81478 4	30.58 79523	11.55 95691	272.6 70687	0.838 84348	16.84 36328	9.236 35913	13.59 51280	10.31 88596	118.9 68829	0.714 50513	13.35 90845	6.596 72734	27.70 59698	11.82 95811	335.0 68308	0.860 89667	16.95 43391	343.5 99121	0.419 89086	0.580 10913	0.725 79394	0.865 71905	0.900 01037	4.873 20622	29.47 88664	12.02 03529	0.867 63570	18.86 87946	1.593 52524	24.98 83657	12.30 32093	0.899 18488	19.54 23450	1.232 61828	20.58 77511	12.57 35321	0.910 78996	21.10 18896	0.607 87497	0.441 03883	
1958	Steelhead	0.7528 01623	0.6358 56424	0.4786 73748	0.5463 33776	125.6 4	128.5 1	133.9 6	138.6	17.38 43032	31.38 52888	12.35 85643	261.8 58227	0.833 76847	16.43 88076	9.139 23260	11.05 30399	11.81 27896	0.706 23611	13.56 37825	6.284 04091	28.92 59161	12.75 95833	326.9 72742	0.856 92999	16.50 98104	339.1 41998	0.305 47692	0.694 52307	0.696 09721	0.852 81058	0.890 06065	4.673 63046	30.67 81274	12.94 06129	0.863 44286	18.31 86679	1.541 23154	25.86 59363	13.15 77920	0.893 38433	18.92 16588	1.193 41772	21.26 81172	13.33 90145	0.905 15580	20.32 35082	0.563 22240	0.377 31591		
1959	Steelhead	0.7418 6261	0.6118 52133	0.4539 1022	0.2622 75555	116.7 4	121.7 9	126.8 5	139.7	20.46 92637	28.91 39485	12.33 84827	205.8 70139	0.863 15265	13.95 45677	13.95 49754	11.52 46286	10.94 31486	10.71 29083	0.781 01037	10.81 16306	6.970 50231	25.99 34460	11.052 11052	270.3 39073	0.863 18117	14.48 057	280.1 96044	0.586 78606	0.413 21393	0.676 39127	0.841 63288	0.880 65118	5.174 23408	27.57 64502	13.04 71437	0.875 80299	16.44 29105	12.458 12458	22.97 45091	13.33 77281	0.886 98842	16.95 07643	1.346 70766	18.84 39723	13.58 75425	0.895 44612	18.12 49380	0.543 25272	0.355 26167	
1960	Steelhead	0.7687 46618	0.6312 21634	0.4852 49497	0.2913 86491	118.7 4	125.7 5	132.3 7	136.4	19.60 00928	28.79 75794	11.90 34437	194.4 93137	0.872 85826	13.97 86132	10.58 35179	11.40 11435	10.45 50104	77.10 76477	0.800 00089	11.50 36449	7.040 61459	25.37 63118	12.33 98226	251.6 35330	0.870 00226	14.23 72175	263.2 25952	0.565 00474	0.434 99525	0.691 49597	0.846 60175	0.884 52935	5.268 28180	26.78 70592	12.55 20401	0.884 41454	16.09 34120	1.787 04543	22.33 21499	12.83 90436	0.891 87300	16.54 57429	1.385 24420	18.32 29354	13.07 30671	0.902 48611	17.70 75654	0.584 00653	0.371 4	
1961	Steelhead	0.7256 30773	0.5871 8597	0.4260 80209	0.2793 12045	121.9 7	128.7 9	135.2 6	145.7	19.04 21803	29.83 97857	12.92 82487	216.8 84348	0.880 93868	14.67 36328	10.62 6552	11.24 26736	11.16 58567	68.54 52377	0.829 38214	11.50 18934	6.463 40727	27.54 83062	13.70 13444	286.3 68372	0.864 37201	14.97 71875	291.6 63330	0.553 56672	0.446 43327	0.654 11347	0.832 82837	0.873 53574	4.868 52097	28.98 57399	13.86 67905	0.876 96739	17.08 40475	1.647 41294	24.26 48329	14.05 00669	0.894 94313	17.67 25072	1.279 24753	19.83 55356	14.18 89915	0.905 95406	18.96 83675	0.516 66283	0.315 51761	
1962	Steelhead	0.7348 39749	0.5852 83064	0.4300 8926	0.4632 78084	129.5 2	135.0 2	140.1 9	136.0	16.43 07147	31.23 53543	13.10 98732	207.3 15359	0.855 68647	14.09 44433	8.146 35913	14.59 51014	11.59 70529	88.55 34698	0.761 58570	11.53 52453	6.329 35445	28.05 70970	13.74 23489	271.8 65359	0.861 94731	14.54 81901	279.5 05493	0.356 09936	0.643 90063	0.650 09301	0.828 81316	4.793 89731	29.43 86751	13.92 63597	0.875 94994	16.36 38740	1.637 28679	24.												

Columbia River System Operations Environmental Impact Statement
Appendix E: Fish, Aquatic Macroinvertebrates, and Aquatic Habitat

Year	Species	InRivSurvSNK	InRivSurvLCol	InRivSurv	ProportionTransported	MedDayLGR	MedDayConfl	MedDayBONinriv	MedDayBONtrans	meanTravelTime	meanMigRate	meanTemp	meanFlow	meanFSpill	meanGas	SNKTravelTime	SNKMigRate	SNKTemp	SNKFlow	SNKFSpill	SNKGas	LCTravelTime	LCMigRate	LCTemp	LCFlow	LCFSpill	LCGas	BonFlow	propBONinriv	propBONtrans	JDAInRivSurv	DeschInRivSurv	BONinRivSurv	JDATime	JDAMigRate	JDATemp	JDAFSpill	JDAGas	DESTime	DESMigRate	DESTemp	DESFSpill	DESGas	BONTTime	BONMigRate	BONTemp	BONFSpill	BONGas	monte_q975	monte_q025
1967	Steelhead	0.7186 16554	0.6228 39236	0.4475 82586	0.4445 76874	128.9 3	131.2 1	137.7 1	147.5 7	20.79 92266 6	28.56 75446 8	12.40 79938 6	220.0 28574 8	0.865 83675 2	15.15 17042 4	11.86 11209 3	10.11 38528 3	11.10 94896 3	81.41 78909 3	0.779 38165 7	12.05 27551 7	6.992 73452 2	25.40 55402 8	12.71 82572 2	277.0 01101 2	0.870 80134	15.28 74105 8	280.3 84948 7	0.384 01148	0.615 98852	0.685 73413	0.847 35136 6	0.885 45674 4	5.212 34688 2	26.83 87124 3	12.89 52566 1	0.880 28649 1	17.27 74272 9	1.767 90404 3	22.59 31841 7	13.14 27192 7	0.902 05480 7	17.81 99831 6	1.371 60268 4	18.50 38840 3	13.37 64824 9	0.916 76253 1	19.25 79593 7	0.520 60457 3	0.359 46826 6
1968	Steelhead	0.6608 76968	0.5351 4937	0.3536 67893	0.2285 05541	114.1 3	120.8 1	128.5 6	146.7 3	24.22 91807 9	25.81 34762	13.05 80840 8	143.2 76956 6	0.874 09859	12.78 47255 6	13.75 80540 1	8.839 90787 1	11.49 29534 9	58.08 04527 3	0.782 82771 1	10.45 26701	8.516 79466 7	20.19 18186 9	13.51 08990 7	177.4 92668 2	0.887 20717	13.06 75009 9	181.4 01397 7	0.575 65359 3	0.424 34640 7	0.609 72380 6	0.804 98847 8	0.850 48363 4	6.357 62189 3	21.22 22063 8	13.68 18302 2	0.902 95326 7	14.73 17596 9	2.247 35932 1	17.83 05617 4	13.97 21107 5	0.910 62219 9	14.84 78943 5	1.744 86284 3	14.22 15287 6	0.931 44309 5	15.96 96073 5	0.435 81713 3	0.262 05521 3	
1969	Steelhead	0.7347 17095	0.5977 224	0.4391 56866	0.6595 59352	130.7 5	129.9	135.0 1	139.3 1	14.39 19128 9	26.24 26242 3	13.36 08285 4	279.9 59191 5	0.822 54081 5	16.96 51348 6	6.773 7	17.38 88056 5	11.76 08011 2	123.7 55114 7	0.674 48746	13.91 02043 2	5.667 67224 7	31.62 90777 4	14.05 42141 6	92202 18939 7	177.4 69748 8	361.2 361.2 2	0.199 68301 7	0.800 31698 3	0.661 96871 6	0.838 02713 7	0.877 56209 9	4.283 72332 5	33.26 19888 7	14.22 66805 6	0.856 32813 2	19.05 29857 6	1.419 46589 9	28.15 74780 8	14.40 06614 7	0.895 98367 6	19.59 55511 7	1.744 37188 4	23.06 75131 9	14.52 92182 3	0.906 95366 3	21.12 21447 5	0.553 27574 3	0.305 11146 6	
1970	Steelhead	0.7482 93213	0.6135 62151	0.4591 24393	0.4663 76252	119.1 6	127.4 4	134.7	144.8 2	22.02 50866	27.74 40799 8	12.03 16771 8	188.3 87293 1	0.870 81285 6	14.39 81763 6	12.51 52088 3	10.25 57495 9	10.57 15372 1	81.73 01452 6	0.777 57954 7	12.10 97173 7	7.554 73626 7	23.52 95129 2	12.51 33819 3	228.2 66876 2	0.882 38869 1	14.41 38329	232.9 47357 2	0.368 10232 4	0.631 89767 6	0.678 10558 1	0.841 17327 1	0.880 30300 1	5.595 10339 1	24.92 11518 1	12.71 55630 2	0.893 67352 7	16.00 20820 6	1.909 37954 3	20.93 89069 6	12.96 21226 4	0.901 21400 8	16.44 03139 9	1.482 08377 5	17.13 85025 9	13.15 50045	0.916 30813 5	17.74 59678 6	0.546 66736 6	0.339 88411 1
1971	Steelhead	0.7435 97792	0.6425 69332	0.4778 13137	0.6436 93304	139.6 3	138.5 7	140.4 3	145.4	14.78 03424 9	34.26 06507	12.82 34466 8	313.8 87293 1	0.819 81285 6	18.70 85336 3	7.332 43381 2	17.34 15371 6	11.59 66598 5	143.8 61837 8	0.669 71806	15.46 28902 4	5.502 42946 3	32.66 83403 4	13.15 09361 5	399.3 85406 5	0.854 79857 5	18.99 47937 3	403.6 70135 3	0.225 20482 3	0.774 79517	0.700 97189	0.857 02485 9	0.892 94111	4.133 30338 2	34.45 82962 7	13.31 02010 3	0.848 17135 3	21.00 06862 6	1.351 79255 2	29.54 78751	13.52 53032	0.904 48192 8	21.27 65242 3	1.047 66625 9	24.27 27404 4	13.73 43254	0.916 37668	22.58 33978 7	0.581 54675	0.374 37342 2
1972	Steelhead	0.7770 15196	0.6431 12015	0.4997 07808	0.4748 53254	124.1 6	122.0 9	127.5 7	140.4 1	16.32 92512 7	32.02 15129	12.35 12833 5	282.8 19567 5	0.838 15059 5	17.40 36672 1	8.280 67212 6	15.04 32516 4	10.76 08106 6	122.3 12300 1	0.716 05471 4	14.11 51786 8	6.082 89186 7	29.69 60081	12.76 93524 4	358.9 46924 8	0.858 97277 8	17.82 59583	353.6 02783	0.376 92811 2	0.623 07188 8	0.702 33889	0.854 84051	0.890 76231 1	4.561 72148	31.36 56419 7	12.95 59322 4	0.858 42081 3	19.87 09396 4	1.512 77780 5	26.43 74250 8	13.27 37967 2	0.896 94114 5	20.15 61749 8	1.175 00397 6	21.60 42654 4	13.57 88359 6	0.905 47362	21.29 73413 5	0.580 34826 1	0.400 94683
1973	Steelhead	0.6792 81812	0.5201 13036	0.3533 03326	0.2440 05822	116.6 2	127.4 2	134.9 6	147.1 4	24.22 40953 1	26.42 27512 6	13.06 14030 7	128.9 79858 1	0.898 79882 3	12.68 33646 6	14.26 43348 9	8.893 19507 9	11.08 09734 3	51.06 13914 5	0.841 01786 6	8.016 75099 9	8.016 26013 2	21.38 69404 5	13.93 57096 4	164.8 51076 8	0.896 34951	12.95 73105 2	172.8 82125 9	0.552 27493 1	0.447 72506 9	0.592 73703 7	0.795 51562 8	0.842 26313 9	6.018 61654 2	22.41 31279 6	14.12 98648 8	0.910 1454 6	14.54 64590 8	2.126 79255 5	18.84 19482	14.33 59069 8	0.910 81533 8	14.65 51682 2	1.652 41830 1	15.40 52777 8	14.48 40512 3	0.930 00310 7	15.57 97114 4	0.452 00959 3	0.257 60143 8
1974	Steelhead	0.7560 37061	0.6380 31162	0.4823 75205	0.4802 24263	134.6	135.8 4	137	140.1 7	14.89 82571 9	34.13 26428 8	12.86 15649 8	301.6 74414 4	0.840 37006 8	18.15 96894 3	7.521 16570 6	16.63 13198	11.31 74419 4	127.1 33361 8	0.724 23911 1	14.79 39346	5.424 20502	33.08 5694	13.31 41301 5	393.9 94984 9	0.857 33091	18.65 46683 3	401.0 10253	0.365 95569	0.634 04430	0.696 75645	0.853 26235	0.889 73253	4.097 82989	34.80 62240	13.48 60769 3	0.849 10737	20.57 46185 3	1.342 08942	29.75 28209	13.76 43060	0.903 02624 3	20.73 65468 3	1.039 75127	24.46 15816	14.01 98431	0.916 01401	22.08 23001	0.587 60015	0.373 98869
1975	Steelhead	0.7869 80391	0.6354 68331	0.5001 01115	0.2738 24252	113.6 8	122.1	129.5 5	138.5 9	20.75 06440 5	28.21 96360 4	11.61 54227 3	191.4 45350 1	0.869 80461 6	13.89 48404	11.34 00389	11.39 11745	10.03 98590	83.35 05172 7	0.784 69971	11.03 72249	7.432 44131	24.07 19994	12.06 71288	239.4 12747	0.875 62784	14.32 02631	246.7 44552	0.592 84527	0.407 15472	0.695 86910	0.847 58312	0.885 13335	5.524 49425	25.48 23530	12.29 27051	0.890 41103	16.02 82375	1.874 77680	21.31 53642	12.62 26924	0.898 11501	16.50 25514	1.454 75553	17.45 60432	12.88 67936	0.911 64937	17.75 46868	0.592 70192	0.383 88825
1976	Steelhead	0.8090 84065	0.6894 89153	0.5578 54686	0.4865 03813	117.3	118.1 2	124.6 7	137.7 6	17.53 94673	30.76 07840 7	11.04 42545 8	252.0 23893 6	0.809 98775 2	15.81 37078	8.844 16001 3	14.72 80118	9.925 17604 8	125.6 42823 8	0.634 53202 8	13.14 49922 1	6.707 58096 7	27.37 61214	11.16 21443	309.3 16747	0.861 19492	15.87 96250	309.3 20007	0.389 10560	0.610 89439	0.741 40507	0.870 61143	0.904 03614 7	4.971 59222 5	29.11 01117	11.39 37017	0.865 82330	17.57 48765	1.648 67030	24.23 68347	11.72 21304	0.886 29134	18.13 03637	1.279 73916	19.82 79133	12.03 10716	0.894 10966	19.56 13737	0.630 18815	0.464 25671
1977	Steelhead	0.6156 64474	0.4956 16139	0.3051 3325	0.1601 21183	122.3 8	129.2 2	135.8 5	134.3	22.24 49068 2	26.57 91097	13.66 51347	113.6 50243	0.912 14291	12.62 72655	12.35 46048	9.672 80706	12.15 40834	38.59 64027	0.873 68511	11.21 68329	7.936 57186	21.27 33486	14.33 26072	152.7 94184	0.900 26319	12.67 04227	158.8 59726	0.653 28141	0.346 71859	0.570 99445	0.783 31824	0.832 18443	6.033 58271	22.11 51035	14.48 05433	0.915 37973	14.34 45514	2.169 81276	18.49 94891	14.63 94359	0.916 88942	13.96 31591	1.688 28076	15.08 11141	14.74 11411	0.939 08721	15.26 04951	0.400 49610	0.208 82237
1978	Steelhead	0.7270 17994	0.5980 06488	0.4347 61478	0.5008 66363	134.7 7	137.4 2	141.8 3	142.9 3	16.45 80411 5	31.15 60018 7	12.90 15492	209.1 19695	0.848 93319	14.14 05997	8.144 27066	14.85 2526	11.61 39616	95.26 70150	0.736 50744	11.56 51327	6.364 21955	27.56 67171	13.39 11574	268.5 33849	0.867 08810	14.57 21655	278.2 64465	0.325 21807	0.674 78192	0.661 83501	0.835 10104	0.875 87464	4.842 41867	28.81 22617	13.54 17476	0.878 37255	16.32 42118	1.672 42118	23.88 39875	13.70 32267	0.887 27627	16.72 17801	1.297 71634	19.55 33064	13.83 68716	0.895 94268	17.77 86073	0.531 68578	0.325 61776
1979	Steelhead	0.7622 29505	0.6352 69516	0.4842 21169	0.4151 76629	119.2 8	125.4 4	131.7 3	136.2	20.53 02159 6	28.70 70899	11.75 03544	194.6 80675	0.860 78638	13.69 01424	11.41 32056	11.36 36989	10.47 96070	80.56 38610	0.768 53364	10.87 23329	7.137 70187	25.25 10983	12.17 47646	249.7 60767	0.868 05712	14.20 89558	260.9 95056	0.429 72076	0.570 27923	0.696 65932	0.850 72913	0.888 20648	5.294 29710	26.77 80874	12.35 77648	0.883 00315	15.91 59853	1.787 42484	22.34 43037	12.57 01379	0.888 94087	16.38 86426	1.386 56158	18.30 56577	12.73 86002	0.897 93732	17.48 1462	0.576 34345	0.374 43645
1980	Steelhead	0.7779 98877	0.6430 20348	0.5002 69108	0.3422 82242	113.4 9	121.1 7	126.7 5	145.																																									

Columbia River System Operations Environmental Impact Statement
Appendix E: Fish, Aquatic Macroinvertebrates, and Aquatic Habitat

Year	Species	InRivSurvSNK	InRivSurvLCol	InRivSurv	ProportionTransported	MedDayLGR	MedDayConfl	MedDayBONinriv	MedDayBONtrans	meanTravelTime	meanMigRate	meanTemp	meanFlow	meanFSpill	meanGas	SNKTravelTime	SNKMigRate	SNKTemp	SNKFlow	SNKFSpill	SNKGas	LCTravelTime	LCMigRate	LCTemp	LCFlow	LCFSpill	LCGas	BonFlow	propBONinriv	propBONtrans	JDAInRivSurv	DeschinRivSurv	BONinRivSurv	JDATime	JDAMigRate	JDATemp	JDAFSpill	JDAGas	DESTime	DESMigRate	DESTemp	DESFSpill	DESGas	BONTTime	BONMigRate	BONTemp	BONFSpill	BONGas	monte_q975	monte_q025	
1985	Steelhead	0.7765 31612	0.6380 11638	0.4954 36206	0.3549 27856	121.0 1	124.8 7	131.1 5	133.3 6	18.08 19829 9	29.34 2263	11.68 06823 9	192.2 70762	0.846 66789 4	13.92 45112 6	8.967 40832	13.53 27828 8	10.51 72941 2	95.50 19973 8	0.724 56046 3	11.76 07278 8	7.128 39239 1	25.03 70400 5	12.03 00199 2	243.2 95079 5	0.871 75883 8	14.24 85450 9	251.6 30340 6	0.496 72591 4	0.503 27408 6	0.697 24160 3	0.850 35782 5	0.887 87432 1	5.336 78036 2	26.41 93663 5	12.23 39910 5	0.886 61235 6	15.83 43004 2	1.823 63157 7	21.93 63447 2	12.45 35315 8	0.893 67425 4	16.18 29185 5	1.416 73862 2	17.91 91261 6	12.62 53414 2	0.904 77764 6	17.24 89757 5	0.594 18982 3	0.375 85194 1	
1986	Steelhead	0.7632 37571	0.6053 5835	0.4620 32236	0.4234 83214	122.5 4	121.4 6	126.8 5	143.1 3	17.65 40732 5	30.00 25568 8	12.45 15361 1	206.7 46303	0.826 57195	14.15 87548 3	8.649 85641 1	14.37 23910 4	10.75 20807 3	106.5 30874 6	0.678 65359 8	11.60 97204 2	7.042 24000 9	12.91 61404 5	256.7 56111 1	0.863 12375 5	14.52 94291 2	258.7 99346 9	0.407 60734 3	0.592 39265 7	0.669 99378 6	0.837 59736 6	5.259 14190 7	26.93 68879 6	13.11 81238 2	0.879 65096 2	16.06 54140 5	1.788 80195 2	22.38 05921 1	13.45 17405 8	0.893 07717 5	16.49 34053 4	1.390 81637 6	18.25 01068 5	13.76 68600 1	0.905 90003 1	17.65 29145 2	0.540 72880 6	0.367 47053 4			
1987	Steelhead	0.5098 89523	0.5105 26423	0.2603 12074	0.1705 19228	131.4 9	130.3	132.6 9	135.8	18.83 50293 1	29.35 63811 5	14.30 66491 4	182.6 11975 5	0.887 78546 9	13.73 96225 2	10.16 63037 8	11.50 57505 8	13.26 15013 1	54.44 44122 3	0.843 86941 2	11.25 39564 1	6.713 08729 8	26.25 32216 8	14.66 79363 5	250.5 79363 5	0.868 27502 6	14.08 98127 6	256.2 69989 9	0.608 92814 6	0.391 07185 4	0.586 77542 2	0.800 37937 9	5.060 49522 1	5.060 79278 1	27.58 04070 7	14.78 75473 2	0.881 02480 2	16.06 56011 6	1.747 99332 8	22.90 33640 4	14.92 71326 1	0.890 85193 5	16.45 30617 4	1.359 21315 1	18.67 15046 5	15.06 47306 4	0.901 19272 5	17.50 36478 5	0.340 03535 7	0.186 56047 7	
1988	Steelhead	0.7016 70375	0.5727 65191	0.4018 92366	0.3401 6287	130.8 6	136.8	142.3 8	141.7 3	19.23 55372 5	28.80 89134 8	12.93 69475 5	163.3 34338 3	0.883 19241 1	13.03 41435 5	10.33 47797 4	11.37 98411 5	11.55 25955 2	62.97 86384 6	0.820 41099 4	10.63 60647 2	6.952 39701 9	24.96 38787 9	13.53 8836	215.9 93962 6	0.877 10664 7	13.50 58543 2	223.5 03921 5	0.464 43216 3	0.535 56783 7	0.639 40130 4	0.822 97982 8	0.865 73339 4	5.270 01562 7	26.09 62100 1	13.70 57022 2	0.895 85218 4	15.29 43264 4	1.843 61633 7	21.72 07107 4	13.84 45959 1	0.899 02291 7	15.60 14932	1.433 56809	17.71 09866 5	13.93 52159 3	0.912 34639 4	16.56 58011 5	0.498 79408 6	0.290 57472 1	
1989	Steelhead	0.7972 17035	0.6579 28545	0.5245 11844	0.2614 37781	114.2 3	121	127.3 8	131.9	18.30 37957 1	29.91 82508 8	11.38 66583 3	218.6 62584	0.844 42458 8	14.45 64503 3	9.562 07111 5	12.94 39627 3	9.989 54238 9	96.24 22958 4	0.728 85453 7	11.81 14849 1	6.745 80563 2	27.02 01620 2	11.78 8836	282.6 54602 1	0.862 94600 4	14.81 44531 2	289.0 10894 8	0.617 94058 7	0.382 05941 3	0.715 11971 3	0.857 80892 6	0.893 59063 9	5.031 90533 8	28.64 41994 5	11.97 99562 3	0.873 07466 3	16.65 25461 2	1.680 60019 6	23.79 70559 6	12.26 95490 5	0.886 97463 5	17.13 68449 5	1.305 61208 7	19.43 52016 6	12.50 50048 8	0.895 8579	18.27 84624 1	0.618 87956 1	0.393 74312 9	
1990	Steelhead	0.5054 94942	0.4880 9082	0.2467 27441	0.2782 91057	137.9 5	135.6 5	135.4 8	147.8	16.98 03977 5	30.39 94122 7	14.97 67987 4	188.8 19301 6	0.873 55391	13.65 53580 4	8.456 57227 2	13.59 16492 6	13.83 01418 3	68.87 32070 9	0.805 41101 7	10.82 82432 6	6.593 52017 9	26.52 74483 4	15.24 30687	250.1 83334 4	0.867 11699 8	14.13 74419 5	254.9 23080 4	0.431 76175 7	0.568 23824 3	0.566 25702 7	0.792 07154 9	0.841 31830 4	5.003 17610 8	27.74 90796 1	15.37 86338 8	0.882 65854 1	16.07 44934 2	1.740 07110 3	23.00 76251 8	15.57 54035 3	0.893 77309 9	16.48 49230 4	1.353 06908 2	18.75 58353	15.79 63347 4	0.907 04035 8	17.61 34929 7	0.330 14608 1	0.169 46540 6	
1991	Steelhead	0.6942 69538	0.5724 30519	0.3974 21072	0.2395 06977	119.7 8	126.1 7	132.2 2	147.6	21.20 59058 8	28.60 71850 1	13.00 40629 3	190.9 84127	0.883 09081 5	13.96 76711 9	12.35 22647 4	9.891 93444 8	11.19 16006 1	63.54 09347 5	0.827 13815	11.08 20976 3	6.905 90553 7	25.72 29931 5	13.69 40536 5	253.2 75581 4	0.871 26375 2	14.31 98913 1	248.1 57099 7	0.587 42900 3	0.412 69891 8	0.640 58432 4	0.823 67123 6	5.181 50692 4	27.10 12120 4	13.87 47812 3	0.883 77952 6	16.29 44774 6	1.784 32317 8	22.48 73394 4	14.11 96454 4	0.898 19677 7	16.72 29617 4	1.390 27404	18.25 71775 6	14.32 52016 3	0.913 06889 1	17.91 52054 8	0.472 53946 2	0.307 68451 5		
1992	Steelhead	0.5246 92973	0.4832 15518	0.2535 39787	0.2164 11336	131.9 8	133.5 5	136.5 3	135.9 6	18.61 33184 1	28.82 40782 9	14.53 01997 3	155.1 21913 1	0.892 30731 6	12.96 63262	9.640 20508	11.77 92276	13.41 73873 9	50.24 47258	0.845 52146 2	10.71 04475	7.024 56041 4	24.67 02523	14.97 86968	210.5 44913	0.877 77372	212.9 96765	0.521 53872	0.478 46127	0.561 43299	0.784 99886	0.834 66074	5.333 26634	25.76 42018	15.09 58286	0.895 94337	15.22 74461	1.876 0828	21.38 73826	15.21 57805	0.900 03486	15.54 20634	1.461 37752	17.37 79815	15.30 94749	0.914 29758	16.51 18045	0.341 08186	0.174 35134		
1993	Steelhead	0.7692 11944	0.6372 68636	0.4901 94646	0.5106 01923	118.5 5	124.6 6	132.1 2	139.9	20.72 14482 7	28.38 36983	11.64 80599 8	206.2 73654	0.858 39545 3	14.62 52007	11.30 66305 8	11.31 87485	10.34 98689	90.92 96310	0.750 11733	11.79 42459	7.443 96352	24.39 59424	11.99 52130	250.8 91082	0.877 82520	14.80 76438	262.4 99511	0.339 73652	0.660 26348	0.700 61547	0.853 95893	0.890 94607	5.466 46058	25.99 08172	12.17 52456	0.887 93113	16.43 22748	1.817 15089	21.96 23659	12.41 77236	0.899 72909	16.97 76773	1.408 48651	18.02 31145	12.62 15248	0.913 83326	18.40 43946	0.574 08606	0.372 02005	
1994	Steelhead	0.5924 53951	0.5152 97826	0.3052 90233	0.2533 29022	128.0 5	130.1 9	134.5 8	137.9 5	20.80 98168 7	28.44 58693 3	13.74 02242	164.3 95310	0.880 53080	13.07 02043	11.84 10807	10.57 18571	12.12 21111	60.41 59912	0.816 06971	10.55 93088	7.017 64260	24.83 68097	14.38 65764	219.4 85834	0.874 51415	13.58 71047	225.8 18893	0.512 99428	0.487 00571	0.588 14991	0.798 44425	0.845 75180	5.302 49773	26.01 74711	14.55 92086	0.892 21892	15.42 28555	1.853 70707	21.60 44401	14.73 25077	0.896 21381	15.77 47974	1.441 58862	17.61 35646	14.88 82789	0.908 63642	16.76 04761	0.400 88061	0.204 37083	
1995	Steelhead	0.7570 93437	0.5761 59082	0.4362 0626	0.4336 45694	116.6 4	123.7 8	130.6 3	138.0	20.14 76258 3	28.59 03835 7	12.62 29158 1	187.5 77940 8	0.860 93088	13.65 52895	10.87 97683	11.65 48018	10.63 75864	83.69 39086	0.759 10573	10.91 36158	7.307 54908	24.42 43195	13.41 53191	232.7 09892	0.876 25100	14.16 52832	243.9 97802	0.384 10367	0.615 89633	0.645 03984	0.825 38179	5.439 18805	5.439 65801	25.83 21391	13.62 65655	0.890 26203	15.77 80618	1.844 76363	21.63 52746	13.90 19886	0.893 70552	16.19 75522	1.429 88331	1.429 87921	17.75 61681	14.11 20929	0.904 63832	17.33 23321	0.530 47157	0.328 12350
1996	Steelhead	0.7411 53962	0.6415 66666	0.4754 99677	0.4103 4337	124.1 8	120.1 7	124.5 3	146.0 8	17.00 30415	31.63 68414 5	12.35 43836	256.4 4841	0.826 19114 9	15.98 86372	8.758 92332	14.67 5167	11.06 57245	117.6 87109	0.679 67008	13.17 91109	6.284 69751	29.00 14138	12.49 00956	325.1 53376	0.861 38795	16.09 66591	335.0 06988	0.430 21526	0.569 78473	0.701 15233	0.853 45153	0.890 6476	4.697 99289	30.70 84709	12.69 93532	0.861 85449	18.00 13713	1.558 24186	25.58 94427	13.05 76181	0.889 73854	18.43 67078	1.206 91751	21.02 15751	13.40 59386	0.902 07481	19.90 17276	0.552 80468	0.380 37091	
1997	Steelhead	0.7802 07275	0.6591 51214	0.5142 74572	0.5804 47767	134.6 2	128.9 4	130.8 1	142.5 7	13.54 75129 9	35.91 3703	12.76 97842	359.1 28302	0.824 17285	21.34 00583	6.493 58417	19.52 77143	11.24 04130	168.0 58038	0.683 76637	18.14 41619	5.102 91953	34.79 64433	13.15 08593	458.0 77341	0.853 8659	21.97 78662	459.8 91793	0.288 08206	0.711 91793	0.714 23284	0.862 36407	0.896 37814	3.855 54321	36.54 90114	13.33 73231	0.841 20812	24.15 69507	1.247 52409	32.02 10481	13.64 33178	0.915 59386	23.87 01508	0.965 85147	26.38 42788	13.93 80674	0.926 26333	24.69 79017	0.601 75223	0.406 84340	
1998	Steelhead	0.7423 8164	0.6047 60174	0.4489 6285	0.6924 92925	126.4 8	125.6 2	130.8 9	136.6	15.94 82643	32.74 99																																								

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Appendix E: Fish, Aquatic Macroinvertebrates, and Aquatic Habitat

Year	Species	InRivSurvSNK	InRivSurvLCol	InRivSurv	ProportionTransported	MedDayLGR	MedDayConfl	MedDayBONinriv	MedDayBONtrans	meanTravelTime	meanMigRate	meanTemp	meanFlow	meanFSpill	meanGas	SNKTravelTime	SNKMigRate	SNKTemp	SNKFlow	SNKFSpill	SNKGas	LCTravelTime	LCMigRate	LCTemp	LCFlow	LCFSpill	LCGas	BonFlow	propBONinriv	propBONtrans	JDAInRivSurv	DeschInRivSurv	BONInRivSurv	JDATime	JDAMigRate	JDATemp	JDAFSpill	JDAGas	DESTime	DESMigRate	DESTemp	DESFSpill	DESGas	BONTTime	BONMigRate	BONTemp	BONFSpill	BONGas	monte_q975	monte_q025					
2003	Steelhead	0.7338 24369	0.5758 68311	0.4225 862	0.3462 29541	125.0 1	129.0 4	135.4 1	142.4 4	18.24 00834 2	29.59 35240 3	12.93 85462 5	197.1 98794 8	0.869 47123 5	13.96 98570 1	9.498 79387	12.62 78629 3	11.24 73556 5	78.20 1297	0.789 27167 7	11.05 70608 1	6.788 04682 9	25.83 64217 4	13.65 25832 8	251.3 35698 4	0.871 03974 8	14.31 56417 2	267.7 48504 6	0.470 33613 5	0.529 66386 5	0.643 44744 9	0.825 89456	0.868 09696 6	5.131 11352 2	27.08 39707 8	13.81 86634 1	0.885 53485 9	16.12 80521 4	1.759 75003 1	22.64 28979 6	14.01 48150 1	0.892 69655 9	16.64 57077 7	1.362 03890 3	18.63 29931 8	14.16 99519 2	0.903 62256 8	17.89 78629 1	0.521 10006 8	0.311 57364 3					
2004	Steelhead	0.7073 8	0.5500 82426	0.3891 17306	0.4622 96621	130.0 1	133.9 5	139.9 5	142.8	17.72 29350 1	30.15 26836 9	13.53 57906 5	188.1 29640 9	0.863 69395 7	13.45 52256 7	9.207 67980 1	13.26 76786 7	11.76 97599 4	20892 3	41065 1	71913 9	6.574 96255 6	26.39 01301 2	14.31 35765 4	241.3 96771 7	0.868 27704 3	14.00 39205 6	261.4 80560 3	0.334 78630 2	0.665 21369 8	0.619 10512 9	0.813 99941 2	5.008 51863 6	27.52 19879 2	14.48 33801 3	0.885 57194 5	15.70 48530 6	1.734 44810 5	22.96 52888 6	14.65 35848 7	0.886 22168 7	16.14 84063 5	1.342 04649 9	18.90 91333 8	14.78 04851 5	0.893 17408 2	17.23 29983 7	0.491 87687 1	0.271 53349 1						
2005	Steelhead	0.6405 95376	0.5255 51618	0.3366 65937	0.4594 18128	127.1 8	129.3 5	135.2 4	142.0 2	17.70 42055 7	29.82 09412 1	14.14 36116 3	178.9 61965 2	0.865 25265 2	13.50 85621 2	8.954 57018 2	13.35 16044 6	12.70 97927 1	76.14 66674 8	0.769 89533 9	11.02 45912 6	6.812 41534 7	25.49 39450 1	14.65 71408 9	228.3 38381 4	0.877 34369 4	13.92 57012 7	236.3 35067 7	0.307 99418 9	0.692 00581 1	0.598 70142 2	0.803 39889 8	0.849 64477 8	5.172 15868 6	26.63 15868 6	14.81 96966 9	0.892 44361 5	15.61 42410 1	1.801 33937 9	22.19 72359 8	15.02 27323 5	0.896 27323 5	16.02 2343	1.398 75929 1	18.14 73470 3	15.19 39358 7	0.908 16846 5	17.08 25519 6	0.441 21424 4	0.225 97769 7					
2006	Steelhead	0.8005 19673	0.6874 20419	0.5502 93569	0.4396 39311	117.2 4	115.2 9	121.1 6	136.6 2	16.77 97690 3	31.42 54383 2	11.09 89287 2	257.1 44044 6	0.810 04396 5	16.02 77590 1	8.218 23055 3	15.97 41227 3	10.04 96715 5	131.4 17466 7	0.632 80801 8	13.60 89533 5	6.565 11237 5	28.02 85092 9	11.20 54389 3	320.8 37081 9	0.862 76313 7	16.18 27864 6	327.5 34210 2	0.433 26475 8	0.566 73524 2	0.739 74020 5	0.870 32359 8	0.903 81016 6	4.864 46657 8	29.81 52266 3	11.42 52784 7	0.863 83966 6	17.81 80982 6	1.607 49826 6	24.83 06058 6	11.73 14335 5	0.889 40925 8	18.18 42626 2	1.246 42626 2	20.35 88338 2	12.02 66418 5	0.898 90345 9	19.47 93195 7	0.633 66674 9	0.441 81291 9					
2007	Steelhead	0.6614 28875	0.5536 83536	0.3662 22278	0.2631 32702	118.3 1	124.3 7	130.3 7	136.7 6	18.79 80475 4	29.79 82100 1	13.55 85482 5	188.3 17156 7	0.886 03071 7	13.63 66295 1	10.26 01868 6	12.34 36907 3	12.00 52412	66.87 05276 5	0.835 17613 7	11.08 62180 4	6.581 04746 8	26.61 05296 3	14.20 47238 6	251.4 16015 3	0.871 42514 2	14.08 78125 8	259.0 45349 1	0.543 44648 6	0.456 55351 4	0.624 47698 6	0.817 22576 7	0.861 17739 6	4.992 97802 9	27.84 29277 5	14.34 79665 8	0.883 82589 8	15.98 23930 7	1.732 53586 1	23.07 67903 2	14.50 94108 6	0.887 74683 1	16.36 61034 9	1.345 50552 8	18.86 07355 7	14.63 17906 4	0.895 34214 1	17.38 34829 3	0.457 96544 3	0.254 07786 1					
2008	Steelhead	0.7352 71981	0.6020 74697	0.4426 88655	0.4863 64332	125.7 6	127.5 8	134.6 6	145.3 5	19.03 77340 5	29.26 01747 4	12.74 89215 3	220.5 76743	0.860 77057 9	15.43 13360 3	10.02 68200 5	12.56 88067 7	11.19 60470 2	98.52 46002 2	0.757 20400 8	12.57 25265 5	7.065 75211 9	24.97 23620 8	13.16 68559 7	265.5 03003 4	0.877 46182 1	15.46 21818 1	274.7 18627 9	0.342 72611 4	0.657 27388 6	0.666 77186 8	0.836 21920 2	0.876 02573 3	5.278 71450 8	26.33 24733 7	13.37 51756 7	0.886 58224 3	17.08 97724 2	1.790 03307	22.25 16012 2	13.69 69099	0.903 36678 4	17.64 89216 5	1.384 87678 8	18.32 77772	13.98 28515 5	0.918 40368 7	19.26 11460 7	0.535 43879 5	0.328 26147 5					
SCN MO1-RESSIM																																																							
1929	Steelhead	0.6943 52172	0.5528 11743	0.3838 46035	0.3577 98101	128.4 7	134.2	141.1 5	144.5	21.48 09091 8	27.32 88149 8	12.88 27810 3	141.8 52836 6	0.922 72786 2	13.61 09204	11.78 44573	10.62 59087	11.39 53443 5	66.85 00335 7	0.864 76066 1	11.60 04423 1	7.748 62341 6	22.12 96295	13.48 35020 7	176.5 48385 6	0.932 39796 2	14.06 49440 3	188.5 38803 1	0.440 38209 9	0.559 61790 1	0.622 06159 7	0.812 68907 8	0.856 05817 9	5.835 11261 6	23.16 14068	13.66 48195 3	0.925 06597	15.56 1129	2.055 25882 5	19.47 28558 5	13.83 85054 3	0.924 14369 2	15.83 51847 3	1.595 78357 6	15.93 88192 3	13.95 54009 4	0.938 98665 9	16.88 75117 3	0.486 74834 7	0.273 39722 2					
1930	Steelhead	0.5079 14706	0.4377 66549	0.2223 48068	0.3126 51501	141.2 9	139.7 1	141.3 4	147.6 1	18.42 13043 7	28.36 24271 9	14.85 98778 6	128.8 57858	0.915 94801 2	12.92 24652 9	8.953 91488 1	12.75 12926 1	13.36 33731 8	63.29 98077 4	0.853 67195 6	10.94 15000 9	7.546 87646	22.30 59968 5	15.37 95353 6	162.8 25569 2	0.925 81877 1	13.43 11912 1	168.1 41385 3	0.372 58614 7	0.627 14166 2	0.514 14166 2	0.757 37569 4	0.811 08207 4	5.765 06140 8	23.12 21826 7	15.54 37925 3	0.920 61398	14.94 33326 7	2.084 76963 6	19.25 64598 2	15.70 33662 8	0.922 81361 4	15.23 87278 9	1.623 13237 8	15.67 63754 4	15.88 75141 5	0.940 05841	16.22 87340 2	0.319 22129 8	0.149 21742 8					
1931	Steelhead	0.5355 80962	0.4041 76132	0.2164 69042	0.2515 775																																																		

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Appendix E: Fish, Aquatic Macroinvertebrates, and Aquatic Habitat

Year	Species	InRivSurvSNK	InRivSurvLCol	InRivSurv	ProportionTransported	MedDayLGR	MedDayConfl	MedDayBONinriv	MedDayBONtrans	meanTravelTime	meanMigRate	meanTemp	meanFlow	meanFSpill	meanGas	SNKTravelTime	SNKMigRate	SNKTemp	SNKFlow	SNKFSpill	SNKGas	LCTravelTime	LCMigRate	LCTemp	LCFlow	LCFSpill	LCGas	BonFlow	propBONinriv	propBONtrans	JDAInRivSurv	DeschInRivSurv	BONinRivSurv	JDATTime	JDAMigRate	JDATemp	JDAFSpill	JDAGas	DESTTime	DESMigRate	DESTemp	DESFSpill	DESGas	BONTTime	BONMigRate	BONTemp	BONFSpill	BONGas	monte_q975	monte_q025	
1941	Steelhead	0.6133 07597	0.4986 73443	0.3058 40211	0.2381 32914	129.4 9	132.7 5	137.8 9	139.4 5	18.13 82831 2	28.91 40247 8	14.30 18195 3	145.8 68231 1	0.931 87627 2	13.58 91001 2	9.055 69284 4	12.67 47961 6	12.99 31711 2	58.23 26980 6	0.898 24339 8	11.60 31559 3	7.144 68794 3	23.95 35861 6	14.85 71922 7	191.0 78867 6	0.925 84197 7	13.92 95887 2	198.5 40481 6	0.536 79006 1	0.463 20993 9	0.573 84004 7	0.788 82368 7	0.836 68863 6	5.440 31899 4	24.93 36613 3	14.99 21032 8	0.917 08307 3	15.65 98577 5	1.928 1184 5	20.77 87951 7	15.13 49846 5	0.916 88436 3	15.94 88198 7	1.499 49669 1	16.94 24784 1	15.23 57382 8	0.932 04712 9	16.91 28575 3	0.410 04302 1	0.204 33776 3	
1942	Steelhead	0.7730 02592	0.6213 34286	0.4802 93014	0.2925 46695	116.7 3	122.1 7	129.3 9	145.1 2	20.04 98690 6	27.92 00356 7	11.71 90028 6	167.9 39068 9	0.907 73734	13.99 37268	10.34 95893	10.30 20803 7	10.30 94926 8	83.54 55764 8	0.831 05611 8	11.76 09848	7.728 44993 3	22.78 58624 6	12.11 54364	207.6 79438 3	0.925 50721 8	14.47 86319 7	211.7 11624 1	0.560 72743 5	0.439 27256 5	0.682 57362 7	0.841 26515 7	0.879 18793 9	5.766 45552 4	24.03 27604 8	12.34 59325 8	0.915 82434 2	16.11 16504 7	2.004 99292 5	19.98 50093	12.61 49133	0.916 55375 6	16.49 99631 7	1.558 94743 7	16.30 74956 2	12.84 30438	0.928 91928 6	17.57 65323 6	0.575 19877 4	0.360 14270 4	
1943	Steelhead	0.7624 73457	0.6230 35134	0.4750 47753	0.4725 98617	126.8 6	128.2 8	130.6 6	132.4 8	15.82 42897 3	31.80 86313 2	12.31 37011 5	235.1 47263 1	0.851 22485 7	15.60 96878 1	7.541 33673	15.99 30349 8	10.94 88946 9	114.7 60279 8	0.724 76254 7	13.58 18790 4	6.307 96489 9	28.56 00564 7	12.76 04664 2	299.4 45922 9	0.882 22297 8	15.64 82521 7	316.8 92730 7	0.367 93547 8	0.632 06452 2	0.683 86759	0.844 24530 4	0.882 97350 5	4.743 25320 9	4.743 13094 8	30.12 67718 1	12.94 67718 3	0.869 42440 9	17.41 38074 3	1.584 18261 3	25.17 05326 7	13.17 07735 1	0.888 81999 3	17.72 07447 7	1.558 07735 7	16.30 11412 9	12.84 55216 6	0.928 76897 9	17.57 00299 8	0.576 05631 5	0.358 63195
1944	Steelhead	0.6985 57451	0.5133 7091	0.3586 19074	0.2342 88339	121.0 4	129.9 6	137.4 6	139.7 2	22.51 61894	26.80 38405 3	13.19 27963 7	124.8 98140 9	0.935 77848 6	13.06 23664 9	12.65 37684 9	9.880 61715	11.18 94582 7	55.07 17567 4	0.905 44843 7	11.51 60350 8	7.913 66183	21.54 16227 7	14.11 27516 4	158.8 50540 2	0.928 94288 9	13.30 80315 5	167.9 65866 1	0.571 34199 9	0.428 65800 9	0.585 65440 3	0.792 74000 3	0.839 27466 8	5.975 61311 4	22.49 87725 4	14.30 82340 2	0.924 34240 6	14.87 97344 2	2.122 15703	18.89 30336	14.48 88773	0.922 72895 6	15.05 99165	1.649 90376 7	15.42 81520 6	14.61 17267 6	0.937 58672 5	16.11 23905	0.464 61075	0.251 69457	
1945	Steelhead	0.7115 99418	0.5774 59635	0.4109 1994	0.5254 75616	128.4 9	129.6 1	135.3 5	138.6 7	18.96 70434 4	29.52 25753 4	13.00 86602 5	186.6 50799 9	0.887 90991 9	14.17 71599 9	10.10 70104 8	12.65 55050 6	11.43 30665 6	85.33 50753 8	0.802 24754 8	11.85 20536 4	6.908 19690 4	25.62 42105	13.60 75484	236.4 32228 1	0.903 25060	14.61 1485	252.2 32193	0.294 61633 5	0.705 38366 7	0.645 03332	0.825 18136 9	0.867 42127 5	5.170 06502 3	27.01 24317	13.79 36903	0.891 98626 3	16.15 72595 6	1.765 90509	22.59 27734 5	14.02 11083	0.896 17180	16.46 39603	1.368 51749	18.54 53243	14.19 80299	0.910 81875	17.44 46110	0.511 62747	0.300 84620	
1946	Steelhead	0.7874 96116	0.6658 10769	0.5243 23394	0.3886 65438	119.7	120.7 5	126.2 2	133.7 2	16.60 96219 9	31.98 01491	11.68 41265	258.7 79430	0.847 86234	15.99 38846	8.468 68381	15.20 1604	10.30 45539	113.4 37806	0.736 63886	13.12 13193	6.154 86223	29.79 96812	12.01 58869	333.5 62164	0.864 48015	16.23 90100	345.2 06817	0.474 98919	0.525 01080	0.721 23982	0.859 57418	0.896 30103	4.599 48451	31.58 39501	12.21 53732	0.849 15336	18.06 80995	1.515 92103	26.29 20521	12.51 57203	0.877 64118	18.31 20861	1.173 46910	21.63 28055	12.78 58481	0.897 99732	19.43 31569	0.604 63445	0.408 30672	
1947	Steelhead	0.5967 7925	0.5471 56892	0.3265 3188	0.5370 57907	134.9	129.1 4	131.0 6	139.3 7	16.65 24427 9	31.39 87386 5	13.94 65896 7	235.7 31177	0.848 26227	15.12 75228	8.333 36943	14.81 50029	12.52 80267	109.0 55976	0.733 64536	12.48 09488	6.374 27941	28.08 53748	14.34 18506	296.7 76092	0.867 90796	15.28 21610	304.4 19799	0.248 559	0.751 441	0.618 20842	0.816 40178	0.861 86262	4.783 78466	29.61 89783	14.50 74262	0.857 43351	17.05 92595	1.621 03963	24.61 45298	14.73 16347	0.878 09066	17.42 98540	1.256 50692	20.19 50378	14.97 95417	0.895 76575	18.61 6539	0.419 5472	0.240 56456	
1948	Steelhead	0.7496 01501	0.6317 19547	0.4735 3792	0.5433 78872	133.1	135.3 7	140.4 6	140.9 9	14.33 07269	34.36 83714	13.23 01939	339.1 6516	0.856 24011	20.23 67309	6.978 61898	17.47 94528	11.78 45270	150.6 66098	0.766 63197	16.99 05029	5.406 11778	32.81 30697	13.78 03189	434.8 27941	0.859 03396	21.28 71405	455.1 99035	0.307 09046	0.692 90953	0.691 88093	0.850 47490	4.065 64652	34.53 05667	13.95 22874	0.841 65742	23.65 22193	1.335 68494	29.91 63929	14.15 10686	0.904 03481	23.37 34181	1.035 45444	24.56 53605	14.30 68471	0.914 56043	23.23 40459	0.570 38962	0.355 06541		
1949	Steelhead	0.7831 33216	0.6337 69097	0.4963 25631	0.4157 159	117.8 6	120.4 6	126.2 4	135.5 8	16.70 26844	31.65 89326	12.23 69916	257.3 76825	0.831 62408	16.00 19165	8.396 77655	15.44 51837	10.36 5769	124.8 89181	0.682 32336	13.38 39569	6.333 16606	28.63 03249	12.80 23390	318.9 30908	0.871 85329	15.99 08125	328.5 31555	0.434 28271	0.565 71728	0.692 94212	0.845 87141	0.883 71873	4.743 12895	30.27 17430	13.04 51458	0.861 87055	17.77 97136	1.573 04212	25.34 46190	13.42 06533	0.884 44471	18.36 61127	1.218 22369	20.83 22238	13.72 66564	0.893 48581	19.89 73617	0.591 50122	0.390 22526	
1950	Steelhead	0.7632 70772	0.6350 63244	0.4847 25213	0.3735 68449	123.0 9	126.7 3	133.1 2	139.6 3	18.94 48438	29.26 33830	11.86 06754	202.6 52782	0.883 83935	14.51 29568	9.928 44085	12.62 02654	10.51 93801	91.18 5289	0.793 04318	11.97 76590	7.043 51376	25.39 75425	12.22 07175	255.3 74519	0.901 42256	14.91 09913	266.7 58117	0.473 39803	0.526 60196	0.695 69347	0.849 85959	0.887 34502	5.259 42086	26.83 66912	12.42 1492	0.889 80617	16.69 14777	1.785 18768	22.36 45171	12.67 31383	0.895 50143	17.08 40870	1.384 36307	18.33 45110	12.89 00036	0.905 11566	18.23 21634	0.576 38848	0.378 88039	
1951	Steelhead	0.7562 78544	0.6211 22868	0.4697 41898	0.4080 97745	120.7 8	122.9 1	128.4 6	134.4 6	16.70 13062	31.41 52266	12.56 57672	242.7 82896	0.853 37731	15.27 46538	8.441 45177	14.49 22339	10.97 84267	101.0 76889	0.745 65739	12.38 07060	6.287 07060	28.85 68346	13.06 08353	313.4 08315	15.48 83313	325.4 32991	0.430 51873	0.569 29962	0.683 25142	0.844 02437	0.882 98802	4.719 94063	30.48 38484	13.25 50165	0.859 07144	17.41 99832	1.568 38910	25.42 96340	13.54 06532	0.881 16033	17.86 55147	1.215 07702	20.88 64787	13.79 28509	0.893 42301	19.13 19551	0.569 00358	0.352 00358		
1952	Steelhead	0.8110 51835	0.6868 73332	0.5570 89877	0.5461 0745	120.2 8	120.4 4	125.9 5	135.1 1	14.71 20925	33.60 82912	11.38 87784	286.5 95312	0.812 78734	17.82 38413	6.650 59133	19.25 30529	10.19 64086	162.5 36511	0.647 68402	16.75 67344	6.074 94881	30.23 04132	11.60 93072	350.6 76730	0.856 79791	17.13 79791	359.5 84442	0.333 91291	0.666 08708	0.738 29479	0.867 65818	0.902 99531	4.535 38479	32.05 79379	11.83 64309	0.840 90070	18.54 22596	1.486 95860	26.82 11730	12.12 07911	0.878 74150	18.71 97977	1.151 65574	22.04 68564	12.38 53411	0.900 7622	19.92 95454	0.638 70130	0.441 70794	
1953	Steelhead	0.7546 4519	0.5868 68444	0.4428 77449	0.4149 21092	122.5 8	126.2 7	133.0 4	144.3 9	17.81 89716	30.44 77619	12.85 25667	211.8 06961	0.876 75075	14.66 51991	9.258 36981	13.58 95425	10.98 61011	92.36 90353	0.784 47835	11.83 13448	6.614 2767	26.91 20828	13.66 95235	267.1 92426	0.892 01991	15.07 28911	280.5 54931	0.410 40226	0.589 59773	0.653 03298	0.829 08597	0.870 53417	4.965 79771	28.35 46614	13.86 34922	0.881 00765	16.78 28689	1.678 33399	23.76 75532	14.08 77316	0.891 26759	17.24 36014	1.300 56934	19.51 04598	14.24 26271	0.904 38321	18.40 98472	0.544 24707	0.311 83059	
1954	Steelhead	0.7874 68726	0.6516 806	0.5131 78092	0.3035 93558	112.9 6	120.2 3	127.6 2	137.7 6	21.13 85754	28.27 09956	11.30 61880	202.3 56375	0.901 89675	14.87 81156	11.82 67329	11.14 68100	9.831 84967	87.39 79782	0.830 03768	12.18 84344	7.327 47643	24.49 65158	11.71 90170	251.7 74749	0.912 72795	15.26 82235	258.7 25158	0.563 7																						

Columbia River System Operations Environmental Impact Statement
Appendix E: Fish, Aquatic Macroinvertebrates, and Aquatic Habitat

Year	Species	InRivSurvSNK	InRivSurvLCol	InRivSurv	ProportionTransported	MedDayLGR	MedDayConfl	MedDayBONinriv	MedDayBONtrans	meanTravelTime	meanMigRate	meanTemp	meanFlow	meanFSpill	meanGas	SNKTravelTime	SNKMigRate	SNKTemp	SNKFlow	SNKFSpill	SNKGas	LCTravelTime	LCMigRate	LCTemp	LCFlow	LCFSpill	LCGas	BonFlow	propBONinriv	propBONtrans	JDAInRivSurv	DeschInRivSurv	BONinRivSurv	JDATTime	JDAMigRate	JDATemp	JDAFSpill	JDAGas	DESTTime	DESMigRate	DESTemp	DESFSpill	DESGas	BONTTime	BONMigRate	BONTemp	BONFSpill	BONGas	monte_q975	monte_q025
1959	Steelhead	0.7359 95572	0.6117 98854	0.4502 81247	0.2752 96817	116.8 8	121.5 3	126.6 1	138.6 6	20.48 66788 6	28.90 82401 2	12.35 79912 2	205.6 18107 4	0.880 30377 9	13.93 23623 2	11.54 78722	10.92 55469	10.70 84682	74.77 10113 5	0.804 24019	10.69 13009 6	6.964 56366	26.00 34743 6	12.88 28819 6	270.2 88037 6	0.883 84215	14.51 69281	280.2 84423 8	0.570 39173	0.429 60826 1	0.676 42944 4	0.840 78140 4	0.880 34007 5	5.169 19428	27.58 66741	13.07 91595 5	0.873 88892 2	16.48 03432 3	1.736 12521 6	22.98 48686	13.37 03915 3	0.885 43166 7	16.90 46576 6	1.345 77010 6	18.85 70385 8	13.61 94891 9	0.897 40294 2	18.04 47750 1	0.539 39743 5	0.352 18617
1960	Steelhead	0.7666 53571	0.6280 93372	0.4815 30026	0.2871 92058	119.0 2	125.8 1	132.4 8	137.3	19.61 28783	28.78 80384 8	11.98 27479	11.98 65459 2	0.909 57754	14.44 04888 2	10.58 69486	11.39 77954	10.45 03973	77.03 74435	0.856 42755	11.91 51893	7.052 81286 7	25.31 03695	12.44 71629 5	250.5 98800	0.908 65796	261.9 66275	0.569 84400	0.430 15599	0.688 72322 1	0.844 49796 1	0.882 21792 3	5.271 53485	26.72 63310 1	12.67 07580 6	0.896 05927 5	16.82 10416 8	1.790 56303 9	22.28 70471 3	12.96 53956 1	0.900 33666 3	17.23 97947 3	1.387 88431 1	18.28 83504 2	13.20 94240 2	0.910 25012 7	18.36 56826	0.581 92144 9	0.361 51238 6	
1961	Steelhead	0.7212 36541	0.5839 95684	0.4211 99027	0.2891 74349	122.0 7	128.9 5	135.7 1	144.8 7	19.15 27807 3	29.63 76912 2	12.94 50832 1	212.7 03719	0.904 28890	14.74 49054 4	10.63 22111 5	11.26 60808	11.16 6	69.09 83367	0.864 42127 2	11.62 25240	6.565 80001	27.06 45519	13.72 45938	279.8 97323	0.889 65663	15.06 26396	286.9 94476	0.540 03409	0.459 96590	0.650 82597	0.829 78336	0.871 22243	4.937 43592	28.48 89562	13.90 01554	0.877 94569	17.13 04054	1.671 04372	23.90 97853	14.08 72879	0.896 33666 3	17.60 37400	1.296 97004	19.56 45470	14.22 88589	0.912 79485	18.83 97569	0.514 46787	0.312 31579
1962	Steelhead	0.7308 38919	0.5836 29272	0.4265 38986	0.4871 90852	129.0 3	133.7 2	139.1 9	136.9 4	16.62 21723 6	30.94 39698 1	13.11 83308	201.2 00528	0.883 83403	14.20 13462	8.207 66793	14.49 72947	11.55 65813	88.47 79296	0.803 07654	11.71 21959	6.461 52462	27.42 49359	13.73 59120	261.9 17404	0.893 04925	14.68 86351	269.2 40112	0.333 81545	0.666 18454	0.648 27836	0.826 84941	0.868 51342	4.888 90184	28.78 00452	13.93 40126	0.881 33987	16.50 77730	1.674 34889	23.90 29321	14.14 35349	0.891 17634	16.79 75559	1.301 64513	19.49 43540	14.30 35321	0.903 27051	17.79 92134	0.547 99083	0.286 99285
1963	Steelhead	0.7033 54653	0.5601 01199	0.3939 49785	0.5675 26379	133.2 5	135.1 3	142.2 1	143.6 4	17.43 27715 6	30.28 96812	13.41 61858	196.6 84671	0.880 18131	14.28 88641	8.773 68490	13.84 43684	11.84 99269	89.94 85290	0.787 18949	11.62 78953	6.716 80230	26.26 27906	14.06 69832	247.5 74984	0.897 76565	14.76 57006	258.4 03747	0.252 33476	0.747 66523	0.629 85603	0.819 14069	0.862 67063	5.058 69490	27.59 83890	14.22 76113	0.886 30631	16.38 51417	1.735 20422	23.03 82621	14.40 38705	0.894 75619	16.76 99680	1.347 40129	18.83 43298	14.54 68125	0.911 88192	17.74 31945	0.511 30174	0.280 20305
1964	Steelhead	0.7388 91118	0.5906 64976	0.4364 37104	0.5103 31021	128.8 3	131.7 8	138.1 4	143.0 9	18.14 64017 9	29.52 13880	12.89 21125	203.2 03195	0.888 35497	14.80 64801	9.169 16105	13.09 88779	11.28 39561	91.23 22174	89.94 36835	0.787 91507	11.62 80230	26.26 27906	14.06 69832	247.5 74984	0.897 76565	14.76 57006	258.4 03747	0.252 33476	0.747 66523	0.629 85603	0.819 14069	0.862 67063	5.058 69490	27.59 83890	14.22 76113	0.886 30631	16.38 51417	1.735 20422	23.03 82621	14.40 38705	0.894 75619	16.76 99680	1.347 40129	18.83 43298	14.54 68125	0.911 88192	17.74 31945	0.511 30174	0.280 20305
1965	Steelhead	0.7772 10152	0.6518 53794	0.5066 27386	0.5423 2386	125.7 6	119.8 9	124.8 3	143.7 1	17.73 42319	31.72 04968	12.05 99237	255.9 24639	0.822 94577	15.88 84814	9.434 68490	14.92 58602	10.42 10638	130.4 90278	0.664 32540	13.47 39208	6.342 46153	28.95 56785	12.41 44417	322.3 32906	0.866 60268	16.03 17850	330.0 48706	0.317 91124	0.682 08876	0.709 45905	0.853 82124	4.707 15183	30.77 52484	12.64 85240	0.855 31674	17.65 77392	1.555 74270	25.66 90554	13.04 63172	0.883 63172	18.06 60464	1.206 76624	21.03 12014	13.39 94064	0.897 10289	19.30 28316	0.585 45015	0.410 36119	
1966	Steelhead	0.6560 63843	0.5290 18108	0.3470 69653	0.3830 28669	130.5 8	136.9 8	141.8 9	135.4 9	17.74 62921	29.54 97528	13.57 27458	169.6 36337	0.909 85321	13.60 26935	9.035 71971	12.89 1	12.16 89830	68.29 04815	0.862 57463	11.55 76389	6.756 86296	25.52 62893	14.30 47458	222.1 39943	0.904 17880	13.89 27261	227.3 65692	0.390 81936	0.609 18064	0.597 32523	0.801 17657	0.848 08246	5.156 00761	26.57 45035	14.48 41138	0.895 54276	15.68 92246	1.815 98672	22.06 22512	14.55 18391	0.898 74659	16.03 74809	1.412 86489	17.96 78004	14.53 90086	0.910 75542	17.10 86225	0.472 43156	0.226 40526
1967	Steelhead	0.7147 24124	0.6193 98193	0.4426 98831	0.4293 78496	129.7 3	131.8 4	138.2 4	147.4 9	20.61 72965	28.64 22068	12.46 07090	218.2 70419	0.890 84621	15.35 8831	11.70 38171	10.28 27904	11.16 47744	83.10 90278	0.824 59307	12.55 47658	6.967 73301	25.44 57196	12.80 89313	275.6 76061	0.891 48053	15.47 57911	279.6 32720	0.397 42062	0.602 57937	0.682 80848	0.844 90006	0.883 84402	5.196 56764	26.86 79332	12.98 05656	0.879 39488	17.39 02229	1.766 75055	22.60 66566	13.20 58232	0.901 24684	17.80 72814	1.370 63555	18.51 68543	13.41 38636	0.920 42076	19.05 17659	0.514 83135	0.354 48340
1968	Steelhead	0.6617 45767	0.5355 20111	0.3543 78167	0.2410 98767	113.7 4	120.3 4	128.1 4	147.9 1	24.41 16164	25.62 80900	13.01 61371	139.8 99577	0.903 59933	12.87 47768	13.78 95108	8.737 38101	11.42 25950	57.31 38389	0.824 69363	10.47 15534	8.669 38431	19.81 77975	13.44 90898	170.9 05789	0.921 15399	13.30 35341	173.4 00299	0.559 09356	0.440 90643	0.610 11515	0.805 15303	0.849 36231	6.462 77959	20.83 80388	13.62 94773	0.919 19648	15.03 45172	2.291 80099	17.51 01690	13.93 69595	0.921 71156	15.38 75096	1.781 23988	14.32 26086	14.21 19078	0.933 15628	16.69 82641	0.438 82714	0.261 92524
1969	Steelhead	0.7298 19159	0.5983 33144	0.4366 74992	0.6494 01527	131.2 3	130.6 9	135.8 2	139.2	14.31 7966	33.87 36804	13.39 67709	279.3 34932	0.836 78492	16.97 34887	6.714 65231	17.56 62767	11.78 83876	124.9 89166	0.705 96840	14.23 62495	5.652 74059	31.66 34532	14.09 95205	355.8 09717	0.864 19129	16.95 42861	360.7 55127	0.206 91876	0.793 08123	0.662 26988	0.836 45312	0.876 64513	4.275 42090	33.28 06518	14.27 75831	0.850 27352	18.91 07070	1.418 71391	28.17 48946	14.45 01174	0.890 00858	19.36 75015	1.100 87911	23.07 80404	14.57 65557	0.903 48464	20.78 03525	0.551 58648	0.305 12293
1970	Steelhead	0.7486 91775	0.6048 08138	0.4528 14878	0.4637 59549	119.2 1	127.3 2	134.7 9	144.5 4	21.97 57581	27.55 67104	12.11 05089	181.5 73547	0.907 10592	14.65 97569	12.36 98015	10.27 35226	10.55 56272	82.14 42306	0.839 72498	12.74 03356	7.652 21435	23.05 41960	12.64 54711	218.0 78854	0.916 80975	14.63 49491	220.6 03805	0.367 49812	0.632 50182	0.669 65346	0.836 03565	0.875 24138	5.684 75706	24.36 39521	12.85 63777	0.908 02763	16.25 09292	1.958 05210	20.44 48183	13.10 31783	0.912 31783	16.78 76866	1.521 42954	16.70 2191	13.29 61311	0.924 50499	18.11 68661	0.540 79633	0.333 73281
1971	Steelhead	0.7386 57167	0.6372 37161	0.4706 99796	0.6247 1299	139.5 6	139.9 4	141.7 5	145.3 8	14.64 18438	34.37 56949	12.95 16276	313.6 34609	0.832 59265	18.61 06025	7.218 88243	17.55 00123	11.65 31639	144.7 29074	0.702 92871	15.73 44291	5.478 67557	32.74 29266	13.35 68185	398.8 80508	0.856 94271	18.65 29626	403.4 26269	0.238 13077	0.761 86922	0.697 11460	0.853 78081	0.890 82686	4.119 80220	34.51 20085	13.50 83339	0.840 90218	20.63 14186	1.349 02089	29.60 36914	13.70 96982	0.897 96982	20.88 91696	1.046 01454	24.31 18902	13.88 46492	0.912 35864	22.21 02174	0.572 40354	0.360 29256
1972	Steelhead	0.7734 00809	0.6423 07149	0.4967 60868	0.4757 64619	124.0 4	122.0 3	127.4 9	140.4 8	16.35 43968	31.97 31918	12.36 48994	281.2 14703	0.858 29545	17.45 43612	8.287 43658	15.02 17846	10.75 96847	121.9 38168	0.758 72052	14.34 61959	6.101 48549	29.59 76538	12.79 61724	356.2 94743	0.870 42250	17.75 60319	350.7 50824	0.375 15209	0.624 84790	0.701 84884	0.852 86441	0.889 98913	4.573 68898	31.26 61341	12.98 45930	0.853 38826	19.75 02979	1.518 22450	26.33 01706	13.29 82727	0.892 63099	19.88 59475	1.178 71624	21.53 56048	13.59 93204	0.909 21080	20.97		

Columbia River System Operations Environmental Impact Statement
Appendix E: Fish, Aquatic Macroinvertebrates, and Aquatic Habitat

Year	Species	InRivSurvSNK	InRivSurvLCol	InRivSurv	ProportionTransported	MedDayLGR	MedDayConfl	MedDayBONinriv	MedDayBONtrans	meanTravelTime	meanMigRate	meanTemp	meanFlow	meanFSpill	meanGas	SNKTravelTime	SNKMigRate	SNKTemp	SNKFlow	SNKFSpill	SNKGas	LCTravelTime	LCMigRate	LCTemp	LCFlow	LCFSpill	LCGas	BonFlow	propBONinriv	propBONtrans	JDAInRivSurv	DeschinRivSurv	BONinRivSurv	JDATTime	JDAMigRate	JDATemp	JDAFSpill	JDAGas	DESTTime	DESMigRate	DESTemp	DESFSpill	DESGas	BONTTime	BONMigRate	BONTemp	BONFSpill	BONGas	monte_q975	monte_q025
1977	Steelhead	0.6123 30316	0.4884 95899	0.2991 20848	0.1321 96746	122.5 6	130.0 3	136.6 9	131.5 4	22.29 71523	26.37 65011 2	13.68 32641 9	106.5 17074 6	0.944 52420 7	12.83 62707 8	12.26 34009	9.728 86719 1	12.18 36595 5	38.56 91101 1	0.915 66946 5	11.31 45801 5	8.079 35306 4	20.76 50672 3	14.36 72380 4	141.9 21361 4	0.940 83241 6	13.11 18009 1	147.5 90301 5	0.698 52950 7	0.301 47049 3	0.563 70675 3	0.778 95061 6	0.826 89067 1	6.151 02705 4	21.55 00091 2	14.51 25896 5	0.937 52262 6	14.80 16477 3	2.226 38171 9	18.05 14879 1	14.65 64559 9	0.936 62804 4	14.99 21391 8	1.733 60982 5	14.70 34539 3	14.74 62973 6	0.951 23976 5	16.07 21769 3	0.395 11406 1	0.203 10592 8
1978	Steelhead	0.7215 33046	0.5971 92078	0.4308 93819	0.5319 9576	134.3 5	136.1 1	140.5 2	143.0 9	16.55 22759 4	31.09 14364 4	12.92 90790 6	209.2 82567 2	0.871 28629 4	14.32 80915 5	8.210 72807 2	14.74 48953 3	11.57 64894 5	95.24 50454 7	0.772 6331 5	11.86 38696 7	6.393 03704 4	27.48 82799 6	13.43 54376 8	268.5 35339 4	0.889 14047 7	14.75 43112 4	278.6 91253 7	0.297 28010 8	0.702 71989 2	0.661 51073 9	0.834 57424 1	0.875 63171 4	4.855 36178 2	28.76 21962 9	13.58 79932 4	0.878 76176 8	16.53 49632 3	1.674 25025 3	23.85 0217 1	13.75 55275 3	0.887 30067 4	16.80 98932 9	1.298 72734 1	19.53 81005 2	13.89 58568 6	0.897 78584 2	17.82 88173 7	0.524 32932 1	0.321 05345 6
1979	Steelhead	0.7552 61567	0.6253 00837	0.4722 6569	0.4245 28925	119.5 8	125.3 8	131.7 4	134.4 5	20.61 18138 6	28.54 16327 3	11.86 91404 2	190.3 67485 2	0.885 15176 9	13.81 78327 4	11.39 29671 6	11.37 48710 4	10.50 68710 3	80.81 24603 3	0.803 04348 5	11.02 83206 9	7.240 64685 4	24.83 58794 8	12.35 88991 2	242.4 48903 4	0.896 15199 1	14.36 72397 9	254.3 59451 3	0.416 26193 4	0.583 73806 6	0.687 91806 6	0.845 96432 6	5.359 79856 6	26.34 99645 3	12.55 03324 5	0.886 05614 9	16.00 88174 8	1.812 41355 8	18.06 86683 2	12.75 60866 7	0.891 76382 6	16.37 78464 9	1.405 38854 9	18.06 24733 7	12.91 62421 2	0.904 87659 7	17.42 79027 7	0.564 26474 5	0.363 13303 8	
1980	Steelhead	0.7778 28098	0.6434 9431	0.5005 27955	0.3508 58371	113.4 6	120.9 4	126.6 3	145.8 8	19.79 38469 1	30.93 55088 8	12.07 70374 7	246.4 54762 6	0.882 20538 6	15.76 61331 7	11.53 19083 5	12.37 55570 3	10.08 75333 8	94.71 44363 4	0.819 26902 5	12.62 88164 1	6.299 83376 7	29.32 49295 9	12.71 89772 3	323.4 85392 3	0.875 75533 7	16.27 88834 8	343.8 81652 2	0.506 41666 2	0.493 58333 8	0.702 65717 9	0.850 18512 1	0.887 86738 3	4.643 33545 4	31.26 91507 7	12.96 93876 3	0.860 32400 1	18.18 94168 9	1.510 33122 3	26.34 12104 4	13.35 23200 8	0.883 31784 4	18.64 71494 8	1.166 94746 2	21.75 48604 8	13.64 96954 7	0.900 17250 2	19.69 60620 9	0.591 60018 5	0.396 94299 8
1981	Steelhead	0.6090 4769	0.5318 24676	0.3239 0659	0.4657 44239	137.2 1	137.3 1	142.2 3	150.8 8	16.77 05127 7	30.97 68249 2	14.41 02478 7	209.9 53986 6	0.878 45734 2	14.68 45924 9	8.376 39042	14.31 94635	13.11 05060	89.14 53369	0.793 01335	11.99 56529 6	6.473 46310	27.10 12586	14.86 71038	267.3 77227	0.888 88956	14.95 26968	274.5 61035	0.301 09163	0.698 90837	0.606 29143	0.809 42819	0.855 43838	4.893 13332	28.41 17731	14.99 46777	0.877 01160	16.71 62735	1.686 88966	23.67 60164	15.17 46206	0.890 85459	17.08 60233	1.308 76685	19.38 84435	15.33 56208	0.907 70110	18.18 54319	0.412 00680	0.235 28695
1982	Steelhead	0.7542 89541	0.6245 68623	0.4711 0558	0.4824 6999	125.0 6	122.7 1	127.9 2	140.5 2	18.43 36101 9	30.46 24887 4	12.34 43188 7	237.9 25398	0.856 34738	15.50 02636	9.801 53259	13.53 94406	10.71 29715	108.6 04202	0.739 74533	12.46 09022	6.668 34355	27.27 89678	12.96 71655	298.9 25221	0.881 68978	15.94 52991	301.6 20391	0.358 15632	0.641 84367	0.686 92296	0.845 52618	0.884 42206	4.946 79631	28.96 21435	12.97 60395	0.866 63487	17.69 44662	1.651 84819	24.17 80363	13.30 73746	0.888 34351	18.00 37800	1.281 57916	19.79 94337	13.61 37504	0.905 51680	19.23 35186	0.550 23437	0.369 76372
1983	Steelhead	0.7653 06222	0.6150 89681	0.4707 3196	0.4399 50873	121.1 6	122.2 8	128.3 8	146.8 5	18.62 73775 5	30.13 87490 4	12.45 02111 2	225.8 18953	0.864 13381	14.85 74499	9.959 65620	12.87 27163	10.65 31112	101.0 35403	0.761 00421	11.97 81120	6.714 04136	26.91 05345	284.9 06621	0.882 14212	15.15 7794	291.5 68944	0.397 31055	0.602 62923	0.678 01464	0.879 95143	4.997 21051	28.51 12192	13.25 88171	16.93 79458	1.673 07947	23.86 66325	13.57 02110	0.888 42662	17.40 86733	1.298 59964	19.53 77747	13.83 77747	0.899 96490	18.74 96490	0.552 39715	0.370 13782			
1984	Steelhead	0.7874 45046	0.6470 4679	0.5095 13789	0.4642 58702	122.6 2	122.1 8	127.8 2	138.6 6	17.89 01825	30.08 99285	11.69 90600	215.6 30365	0.850 48036	15.11 95405	8.809 62287	14.70 32693	10.29 66077	121.8 24601	0.709 07404	13.28 84832	7.106 77374	25.60 49630	11.91 32417	261.7 02868	0.893 55933	15.32 35747	267.1 82830	0.391 36186	0.608 63813	0.706 52759	0.853 26907	0.890 33660	5.259 38572	27.21 03217	12.13 39345	0.880 45983	16.71 94919	1.766 79788	22.63 64611	12.50 31782	0.890 46969	16.92 42499	1.372 45236	18.49 24899	12.85 66980	0.905 4223	17.96 98228	0.590 94643	0.405 48772
1985	Steelhead	0.7706 38404	0.6307 57102	0.4860 85646	0.3743 27509	120.7 9	124.4 2	130.7 9	132.4 6	18.12 42136	29.29 30273	11.78 26866	189.6 06241	0.867 54682	13.97 80483	8.995 38511	13.52 25356	10.51 36228	95.72 31170	0.751 01076	11.71 84017	7.143 39378	24.91 86448	12.20 10555	239.9 45533	0.898 43423	14.38 17360	248.1 57028	0.471 54406	0.528 45593	0.690 59725	0.846 39094	0.884 73682	5.350 59621	26.27 96892	12.41 25083	0.888 92326	16.01 78318	1.834 01307	21.81 64626	12.62 54463	0.895 05521	16.32 55306	1.425 02835	17.81 59463	12.78 71084	0.908 85502	17.32 36417	0.585 15095	0.365 20901
1986	Steelhead	0.7602 56094	0.6038 50216	0.4590 80806	0.4176 64077	122.8 8	121.6 3	127.2 3	143.6 2	17.60 54685	30.01 09330	12.47 18381	205.9 33934	0.868 66565	14.74 36457	8.630 63518	14.39 80553	10.77 58979	106.7 02407	0.750 79413	12.28 93201	7.013 28984	25.47 37413	12.94 15011	255.7 21796	0.901 22500	15.21 29347	257.2 99713	0.413 13428	0.586 86571	0.668 10166	0.835 28143	0.875 27261	5.248 1573	26.88 90265	13.14 76064	0.888 19971	16.83 04220	1.791 94445	22.33 94623	13.47 48525	0.900 08151	17.04 51873	1.393 13829	18.21 99360	13.78 56988	0.916 88361	18.05 21268	0.539 53325	0.363 92660
1987	Steelhead	0.4991 9488	0.4989 57064	0.2490 76812	0.1825 04512	132.3 6	130.5 9	132.2 5	132.1 5	18.98 07378	29.06 01450	14.29 60599	176.5 97094	0.913 72708	13.75 25919	10.19 15235	11.46 46633	13.30 89677	54.03 34915	0.878 21993	11.19 42306	6.828 08391	25.69 34817	14.70 41355	0.900 18003	14.17 32922	244.3 7	0.580 94683	0.419 05316	0.576 02734	0.794 75421	0.842 75122	5.149 63630	26.96 26858	14.81 00771	17.926 98611	16.20 92638	22.39 89842	14.89 34024	0.897 65499	16.58 76913	1.390 57470	18.25 32538	0.909 08635	17.61 10534	0.328 21681	0.174 69684			
1988	Steelhead	0.6993 0628	0.5614 7847	0.3926 4542	0.3314 26422	130.5 1	136.1 4	141.9 7	142.6 6	19.44 56100	28.43 02318	13.00 95968	150.7 74875	0.918 65583	13.24 92048	10.34 41586	11.32 77067	11.53 13217	62.67 21984	0.873 59756	11.34 62431	7.156 78837	24.06 14901	13.62 69516	197.0 50867	0.915 53288	13.52 15410	202.8 10104	0.470 79897	0.529 20102	0.628 30504	0.816 00087	0.859 35628	5.436 93604	25.09 74523	13.80 37605	0.907 98143	15.24 74865	1.919 83344	20.88 70402	13.95 86594	0.909 37610	15.60 37610	1.494 35006	16.99 99182	14.06 73706	0.922 81838	16.62 43032	0.487 20639	0.287 5
1989	Steelhead	0.7895 38297	0.6551 4153	0.5172 59328	0.2772 09509	114.1 3	120.7 9	127.1 7	131.3 5	18.39 69197	29.84 42794	11.43 16130	217.4 46718	0.855 75317	14.34 48734	9.631 33174	12.86 21244	9.983 42113	95.94 71191	0.737 60418	11.59 19195	6.769 77065	26.92 18713	11.85 97463	280.2 78152	0.882 08752	14.75 48845	286.7 2	0.596 26711	0.403 73288	0.712 73121	0.855 99132	0.892 26295	5.047 46440	28.53 52902	12.06 66549	0.872 67049	16.63 16885	1.686 48700	23.71 03894	12.35 51100	0.885 51100	17.07 74097	1.310 07055	19.36 91741	12.57 98788	0.895 44346	18.20 85943	0.611 15744	0.386 62283
1990	Steelhead	0.5087 3546	0.4874 77096	0.2479 96885	0.2796 37464	137.3 9	134.5 1	135.2 9	148.9 9	17.10 74191	30.19 02657	14.98 30562	185.0 20307	0.904 3596	13.98 87128	8.485 82909	13.49 70400	13.76 33115	68.45 79162	0.851 46278	11.29 94924	6.694 97122	26.05 51058	15.23 19474	243.1 79565	0.900 62017	14.45 74027	247.0 55023	0.434 31982	0.565 68017	0.565 48986	0.790 51822	5.079 87441	27.24 033																

Columbia River System Operations Environmental Impact Statement
Appendix E: Fish, Aquatic Macroinvertebrates, and Aquatic Habitat

Year	Species	InRivSurvSNK	InRivSurvLCol	InRivSurv	ProportionTransported	MedDayLGR	MedDayConfl	MedDayBONinriv	MedDayBONtrans	meanTravelTime	meanMigRate	meanTemp	meanFlow	meanFSpill	meanGas	SNKTravelTime	SNKMigRate	SNKTemp	SNKFlow	SNKFSpill	SNKGas	LCTravelTime	LCMigRate	LCTemp	LCFlow	LCFSpill	LCGas	BonFlow	propBONinriv	propBONtrans	JDAInRivSurv	DeschInRivSurv	BONinRivSurv	JDATime	JDAMigRate	JDATemp	JDAFSpill	JDAGas	DESTime	DESMigRate	DESTemp	DESFSpill	DESGas	BONTTime	BONMigRate	BONTemp	BONFSpill	BONGas	monte_q975	monte_q025
1995	Steelhead	0.7509 20724	0.5747 24994	0.4315 72909	0.4448 85094	117.0 6	123.6 7	130.6	137.5 7	20.22 83853 2	28.49 57243 4	12.63 97365 8	185.5 69036 2	0.881 61086 2	13.75 41481 8	10.91 03078 8	11.60 99916 6	10.63 19984 4	83.80 32287 6	0.787 93883 8	10.99 59127 4	7.358 13420 3	24.23 47284 9	13.44 07650 6	229.6 18395 5	0.900 47675 4	14.25 87929 6	241.1 13433 8	0.372 81433 7	0.627 18566 3	0.643 31084 1	0.823 87173 4	0.866 27599 8	5.472 80209 5	25.63 67957 4	13.66 03818 9	0.890 95329 8	15.83 63468 2	1.856 67403 8	21.49 05889 7	13.93 93418 6	0.896 04153 2	16.21 60905 2	1.438 66764 8	17.64 89055 8	14.15 18721 6	0.911 75356 5	17.31 77828 8	0.527 41690 9	0.323 86638 4
1996	Steelhead	0.7374 83195	0.6407 85424	0.4725 68482	0.4020 24535	124.5 8	120.3 4	124.7 2	146.2 1	16.92 77650 6	31.65 16484 4	12.37 94806 3	255.7 58276 3	0.844 65915	16.09 74131	8.685 14253 2	14.77 34312	11.09 46975 7	118.5 76231 4	0.723 54205 8	13.55 16250 6	6.282 96969 1	28.95 79423 7	323.7 40554 3	0.867 92001 1	16.13 33831 9	333.4 51477 1	0.438 28834 6	0.561 71165 4	0.700 51890 3	0.851 48987 4	0.889 92781 8	4.697 36311 6	30.65 34706 4	12.73 88591 8	0.854 26625 3	17.99 21272 3	1.561 79020 6	25.52 47057 5	13.08 65259 2	0.880 31361 5	18.26 47508 8	1.209 36299 1	20.98 57556 8	13.42 61794 1	0.899 28951 9	19.48 79474 6	0.549 45707 9	0.379 57160 2	
1997	Steelhead	0.7773 25139	0.6563 60203	0.5102 05286	0.5367 94506	135.1 5	134.5 9	136.2 4	141.8	13.38 64217 7	36.07 60976 1	12.89 26380 7	358.4 50425 3	0.838 48454 7	21.04 38848 9	6.359 34004 2	19.82 43479 7	11.33 82391 8	168.4 26577 8	0.726 97894 6	18.38 34060 7	5.076 33405 9	34.92 38017 8	13.34 16296 6	457.5 95443 7	0.850 64847 3	21.21 40955 9	460.2 17590 3	0.324 40192 3	0.675 59807 7	0.711 91548 5	0.859 20251 8	0.894 28610 3	3.839 23822 6	36.65 85727 5	13.53 19812 8	0.830 90022 8	23.28 43494 4	1.243 78523 2	32.11 68269 8	13.81 43453 6	0.908 75593 8	23.04 83506 5	0.962 89265 2	26.46 78319 4	14.07 74130 8	0.921 89723 3	24.18 14699 2	0.598 91081 6	0.406 47707 4
1998	Steelhead	0.7408 42412	0.6051 6365	0.4483 30899	0.6823 36982	126.6 3	125.7 9	131.0 8	136.8	15.81 20595 4	32.86 57974 7	13.14 10254 1	267.4 30075	0.840 58679	16.37 20453 6	7.983 88973 6	15.76 38641 3	11.37 64484 4	122.0 29185 5	0.716 92302 8	13.83 55102 5	5.870 76626 1	30.92 30823 9	13.88 15701 3	344.0 93350 4	0.863 53944 7	16.41 80371 1	358.8 18072 9	0.187 42512 3	0.812 57487 7	0.669 58317 1	0.838 17223 1	0.878 34162 8	4.389 91484 8	32.72 74896 8	14.07 10865 2	0.848 13777 2	18.27 29763 3	1.442 31153 4	27.66 23399 4	14.29 72364 4	0.885 99330 2	18.68 66639 5	1.117 27625 9	22.73 41613 1	14.45 99471 5	0.904 19977 9	19.93 86873 2	0.560 28744 6	0.327 30173 6
1999	Steelhead	0.7324 38958	0.6031 88785	0.4417 98965	0.4930 6821	133.5 4	134.2 2	139.5 4	146.7 7	16.27 95759	31.80 30118 8	13.07 26681 4	239.2 87410	0.862 80842 8	15.50 84476 1	8.105 12806 5	15.14 79068	11.48 53628 2	106.7 79931 6	0.759 33125	12.79 69495 8	6.231 18633	28.72 40988 9	13.57 34020	304.3 12739	0.880 44378	15.66 70885	316.1 18072	0.336 74026	0.663 25974	0.667 77048	0.837 40141	0.877 48389	4.691 39200	30.25 09917	13.74 86835	0.867 46646	17.51 29961	1.574 42854	25.35 42190	14.01 88512	0.889 89782	17.95 24838	1.220 82503	20.78 75801	14.26 60102	0.904 22600	19.23 63586	0.534 07367	0.337 66941
2000	Steelhead	0.6346 02714	0.5668 43097	0.3597 20168	0.3770 11452	130.2 4	129.1 2	132.5 2	143.1	18.12 94123 8	30.28 02019	13.29 89606	198.8 49444	0.877 61537	14.12 10390	9.565 83134	13.39 51892	11.85 38269	88.30 67947 4	0.791 67474	11.66 42576	6.612 86006	26.75 80345	13.62 01036	25.94 32683	0.888 04046	14.65 48426	269.6 77734	0.410 64148	0.589 35851	0.634 50592	0.822 02033	0.865 67571	4.993 08811	28.09 99782	13.80 28060	0.877 74040	16.41 14988	1.714 48437	23.30 91050	14.07 63556	0.886 04935	16.60 20793	1.330 92986	19.06 64390	14.37 09206	0.899 6526	17.55 23228	0.446 51879	0.278 11338
2001	Steelhead	0.6623 93326	0.4948 1457	0.3277 61869	0.2634 76052	131.8 9	137.3 4	143.0 2	138.7	19.61 22183 4	28.03 50621	13.78 73371	130.8 34572	0.935 75581	13.39 72790	10.27 28313	11.67 23103	12.02 10229	58.80 80848	0.894 62251	11.46 80776	7.392 28712	22.77 27733	14.66 44875	166.9 98995	0.937 91169	13.83 58169	174.2 12005	0.514 63749	0.485 36250	0.566 65074	0.782 57762	0.830 59931	5.654 20483	23.59 06004	14.82 69798	0.931 42703	15.46 39698	2.031 64314	19.73 80342	14.93 80331	0.929 93168	15.79 07495	1.580 59292	16.08 87119	15.00 20978	0.944 20978	16.81 87332	0.435 45409	0.223 96450
2002	Steelhead	0.7373 06238	0.6041 79653	0.4454 65427	0.3004 75812	122.8	128.0 2	133.8 8	143.6	19.40 46484 1	29.05 52207	12.51 75375	193.3 15719	0.906 47263	14.40 11462	10.57 02238	11.52 69727	10.88 46777	75.12 49939	0.852 73860	11.90 96324	6.876 20829	25.58 08322	13.01 84874	25.04 10196	0.904 48767	14.73 93790	256.8 59130	0.537 13316	0.462 86683	0.666 68431	0.834 02238	0.874 09605	5.187 10696	26.85 19126	13.23 10352	0.892 68041	16.72 98006	1.789 25158	22.32 43703	13.52 49261	0.899 10952	17.02 94440	1.388 14636	18.28 49335	13.78 51328	0.911 62639	18.16 17460	0.539 26113	0.335 83148
2003	Steelhead	0.7302 74949	0.5774 19479	0.4216 74981	0.3373 54578	125.6 8	129.6 7	136.2 2	141.9	18.16 29155	29.67 37776	12.96 06093	198.4 41816	0.896 89119	14.24 87295	9.444 58909	12.72 67289	11.26 12468	79.26 25717	0.830 12026	11.23 71913	6.765 34374	25.93 59365	13.67 69306	252.5 02540	0.900 97950	14.67 11240	270.0 75286	0.482 19599	0.517 80401	0.644 34258	0.825 69750	0.867 77889	5.108 70011	27.20 38960	13.85 01634	0.890 86293	16.55 01741	1.749 10916	22.76 93447	14.04 82724	0.898 18400	17.07 99878	1.353 15467	18.75 46463	14.20 57032	0.910 86766	18.30 74569	0.521 34117	0.310 08337
2004	Steelhead	0.7052 30363	0.5475 50781	0.3861 49436	0.4427 14743	129.4 9	133.1 3	139.3 7	144.8	17.78 34128	29.90 02630	13.53 98659	180.9 91201	0.902 97681	13.84 81146	9.131 89731	13.27 85786	11.77 66237	77.60 17547	0.841 11778	11.59 83371	6.713 69564	25.75 01550	14.29 83791	230.4 20074	0.906 01460	14.20 10245	249.9 50042	0.353 47946	0.646 52053	0.616 11718	0.812 10564	0.856 91688	5.113 36648	26.84 18085	14.47 71991	0.895 26757	15.91 37023	1.777 15516	22.41 39171	14.65 65710	0.894 87252	16.26 71950	1.375 01907	18.45 82226	14.79 62269	0.904 26328	17.35 06088	0.490 20834	0.268 11969
2005	Steelhead	0.6332 73207	0.5187 46468	0.3285 0824	0.4268 57014	129.4 9	130.4 3	136.1 4	141.4	17.52 36750	29.78 85853	14.20 99527	174.6 40148	0.899 42024	13.92 47878	8.743 10760	13.57 86608	12.79 46620	77.27 31292	0.826 73006	11.59 96568	6.842 21847	25.24 84367	58102 50670	0.909 70587	14.32 49289	228.4 40643	0.337 67691	0.662 32308	0.591 46652	0.798 59044	0.845 59921	5.202 36702	26.33 75580	14.91 31761	0.899 90049	15.99 62574	22.91 72916	21.95 06190	15.09 43613	0.902 33892	16.29 22719	1.414 73390	17.94 43047	15.23 46468	0.917 80629	17.28 12218	0.433 94506	0.218 93175	
2006	Steelhead	0.7977 91195	0.6811 06319	0.5433 80624	0.4349 158	117.5 5	115.4 2	121.3 7	136.8	16.77 18098	31.36 69892	11.23 40049	255.5 48720	0.832 45285	16.21 23355	8.177 97511	13.57 81739	10.05 53146	131.9 16893	0.683 30541	13.87 58106	6.600 20679	27.81 06082	11.41 38887	317.0 53578	0.872 96922	16.37 18115	323.8 00262	0.435 67779	0.564 32221	0.734 61779	0.866 56990	0.901 85193	4.886 29180	29.58 33121	11.64 21964	0.858 39613	17.92 97208	1.618 46757	24.64 56030	11.94 23410	0.881 42367	18.12 73804	1.254 35868	20.22 27146	12.23 54848	0.898 86005	19.18 59184	0.625 51591	0.438 02638
2007	Steelhead	0.6545 04784	0.5487 06631	0.3591 31115	0.2514 97663	118.6 9	124.7 4	130.8 4	132.2 1	18.79 61918	29.62 24133	13.58 13834	182.4 56726	0.911 47249	13.77 84881	10.20 61312	12.35 16614	12.05 16614	66.49 41001	0.874 91958	11.41 63763	6.628 81599	26.23 37653	14.25 58169	243.0 31356	0.897 66974	14.14 64521	248.9 09881	0.557 61003	0.442 38996	0.618 90357	0.813 52372	0.858 34920	5.046 89334	27.37 49194	14.39 58936	0.888 54789	16.04 35485	1.763 42372	22.67 70725	14.53 29246	0.893 00123	16.30 85295	1.369 68357	18.52 96339	14.63 1073	0.905 56487	17.30 32994	0.452 42584	0.245 5
2008	Steelhead	0.7364 01344	0.5967 01215	0.4394 11577	0.4700 78329	125.5 6	127.6 9	134.8 6	146.2 5	19.02 63534	29.12 81179	12.80 00551	217.8 52396	0.899 29765	15.92 04130	9.925 06961	12.59 77601	11.18 28903	98.27 24578	0.822 03626	13.39 63504	7.158 25189	24.60 41517	13.24 82741	259.3 69450	0.913 33125	15.85 53922	268.3 96453	0.356 27824	0.643 72175																				

Columbia River System Operations Environmental Impact Statement
Appendix E: Fish, Aquatic Macroinvertebrates, and Aquatic Habitat

Year	Species	InRivSurvSNK	InRivSurvLCol	InRivSurv	ProportionTransported	MedDayLGR	MedDayConfl	MedDayBONinriv	MedDayBONtrans	meanTravelTime	meanMigRate	meanTemp	meanFlow	meanFSpill	meanGas	SNKTravelTime	SNKMigRate	SNKTemp	SNKFlow	SNKFSpill	SNKGas	LCTravelTime	LCMigRate	LCTemp	LCFlow	LCFSpill	LCGas	BonFlow	propBONinriv	propBONtrans	JDAInRivSurv	DeschInRivSurv	BONinRivSurv	JDATime	JDAMigRate	JDATemp	JDAFSpill	JDAGas	DESTime	DESMigRate	DESTemp	DESFSpill	DESGas	BONTTime	BONMigRate	BONTemp	BONFSpill	BONGas	monte_q975	monte_q025
1933	Steelhead	0.7011 67656	0.5604 4802	0.3929 68025	0.3860 91511	125.7 1	127	132.5 9	145.1 7	19.42 40975	29.46 29593	13.01 8	198.7 03711	0.822 68013	12.13 69628	10.72 01812	11.68 56912	11.31 86874	72.99 80621	0.723 54184	9.786 74259	6.755 59860	26.23 42197	13.59 11515	258.8 97499	0.816 63587	11.52 66097	270.0 96771	0.413 02196	0.586 97803	0.644 15904	0.825 02179	0.868 62224	5.079 07587	27.60 71287	13.78 02091	0.843 45914	12.85 55330	1.737 84643	22.99 51107	14.06 91814	0.844 69131	14.00 59286	1.348 98796	18.81 22823	14.30 54680	0.857 15803	16.16 68953	0.485 24222	0.296 58628
1934	Steelhead	0.4309 31689	0.4764 79912	0.2053 30293	0.2585 81063	141.3 1	138.6 4	136.4 1	141.1 9	15.70 40054	31.77 55422	15.03 62608	206.7 52097	0.862 76419	12.78 16306	7.787 71245	14.26 37648	14.25 24309	58.40 38597	0.823 85302	84111	5.975 20066	29.36 15605	15.26 19886	288.5 36839	0.826 57222	11.95 20153	294.9 33044	0.417 56421	0.582 43578	0.561 47130	0.790 88841	0.842 18645	4.579 84805	30.57 93216	15.32 95274	0.832 07683	13.17 60919	1.588 51226	25.19 31033	15.41 55944	0.841 02668	13.53 80369	1.234 79994	20.55 12110	15.54 90341	0.855 98278	15.70 93787	0.269 75718	0.140 12344
1935	Steelhead	0.6834 41267	0.5332 05372	0.3644 14555	0.4226 41057	124.7 8	130.1 3	136.8 1	139.1 3	19.34 88864	28.99 13469	13.22 24245	175.7 41797	0.827 05771	11.28 51573	10.48 96266	11.51 14877	65.10 99564	0.737 19847	9.290 72475	6.907 95742	25.32 91537	13.93 33335	230.5 42579	0.815 46977	10.64 09919	241.3 03634	0.361 36701	0.638 63298	0.622 00501	0.815 95847	0.861 05574	5.227 24019	26.53 07176	14.10 76215	0.853 74257	11.87 64331	1.813 21346	22.06 53046	14.30 02417	0.848 15057	13.23 49564	1.408 86231	18.01 83657	14.44 67339	0.853 74516	15.31 61811	0.474 16881	0.262 37293	
1936	Steelhead	0.6804 24262	0.6220 82989	0.4232 80359	0.4194 04814	117.6 4	118.4 6	124.6 8	139.7 2	18.85 33057	30.29 11309	11.86 74683	233.1 87121	0.762 85395	13.42 49485	10.10 55828	13.59 03870	10.66 70908	115.4 94595	0.568 45639	12.03 98157	6.772 99619	27.01 87182	11.94 82363	292.2 34263	0.806 27918	12.21 65557	303.0 46356	0.400 41359	0.599 58640	0.693 35072	0.849 44818	0.891 32109	5.003 94631	28.75 11466	12.18 17377	0.812 10539	13.13 17142	1.671 38635	23.84 98114	12.52 3441	0.825 72144	13.68 22446	1.294 29783	19.60 49063	12.88 79518	0.859 37252	15.91 44592	0.491 20104	0.354 71057
1937	Steelhead	0.7111 99655	0.5455 62242	0.3880 03678	0.3606 62544	119.0 7	128.2 8	135.3 6	134.1 2	24.05 92836	26.39 13444	12.31 47929	138.7 26340	0.820 10426	10.64 44332	14.03 14428	9.125 62046	10.64 10968	55.80 67169	0.747 78651	9.300 88920	8.057 19645	21.57 10071	12.96 24859	178.7 07016	0.790 42149	9.721 00512	191.5 12069	0.438 64324	0.561 35675	0.632 97436	0.813 97738	0.864 53279	6.004 32665	22.72 14715	13.16 96422	0.819 67423	10.69 99519	2.095 31255	19.05 51335	13.42 05249	0.820 22450	11.61 34967	1.622 74144	15.67 99859	13.60 56852	0.875 75855	12.98 25997	0.485 80257	0.286 48968
1938	Steelhead	0.7653 31649	0.6416 20329	0.4910 52345	0.4581 47838	117.7 3	119.1 9	124.1 8	138.6 9	16.33 49469	32.17 96101	11.88 45639	253.7 40281	0.786 43926	13.88 38131	8.208 26371	15.93 12924	10.59 26429	120.7 91062	0.601 49027	11.98 74376	6.149 69909	29.50 99626	12.10 80174	331.0 11962	0.833 78343	13.12 22011	344.2 80426	0.387 12743	0.612 87256	0.708 36779	0.856 55542	0.894 39682	4.605 86226	31.20 50727	12.28 36332	0.835 78912	14.38 32382	1.533 26894	26.03 82742	12.60 55800	0.853 49472	14.83 77819	1.188 95022	21.34 86731	12.92 80786	0.872 96587	16.96 71540	0.585 12262	0.393 70845
1939	Steelhead	0.4977 59178	0.4766 42015	0.2372 52938	0.5308 08586	140.5 7	140.8 9	133.4	139.4 9	18.04 38002	29.15 35238	13.55 26253	169.0 98266	0.801 13003	11.15 80218	9.016 25777	13.17 01900	12.93 10968	72.80 67169	0.681 73078	9.380 39341	7.066 36296	24.49 28905	13.89 39593	216.5 30428	0.801 19455	10.46 37463	0.200 70336	0.799 72718	0.568 46417	0.791 95734	0.845 02831	0.845 40057	25.59 99435	13.95 84391	1.892 83229	21.17 84702	13.89 63638	0.831 98648	12.62 05949	1.473 06425	17.24 19446	13.89 56852	0.856 48274	14.45 75281	0.323 34619	0.161 32958			
1940	Steelhead	0.6135 26215	0.5346 79981	0.3280 40185	0.4575 94909	123.3 8	123.3 9	129.1 3	142.1 1	19.15 22770	28.75 69061	13.19 84957	176.5 84941	0.785 78106	11.03 23059	9.861 37447	12.36 30618	11.64 33921	79.71 59881	0.637 20186	8.863 27819	7.340 26049	24.06 21829	13.53 20205	224.4 86106	0.802 48759	10.56 78973	231.3 29704	0.311 70295	0.688 20327	0.624 28956	0.815 77067	0.861 85836	5.499 56408	25.34 99435	13.73 33519	0.837 88681	11.67 68442	1.903 72373	21.01 66427	14.07 66900	0.833 55013	12.84 60283	1.478 77450	17.17 63088	14.41 71214	0.849 05374	14.77 19998	0.408 9839	0.245 91306
1941	Steelhead	0.6058 74213	0.4833 09662	0.2928 24861	0.3754 69399	126.9 7	129.0 2	135.2 6	141.7 9	18.69 04714	28.48 59264	14.12 65974	145.8 20126	0.822 75676	10.72 16068	9.430 77910	12.12 93939	12.80 56879	56.75 72814	0.769 48494	9.503 83453	7.322 54058	23.39 63882	14.60 40017	190.9 52841	0.778 47132	9.644 78463	198.7 47863	0.363 21500	0.636 46985	0.576 46985	0.787 6698	0.843 98123	5.560 97358	24.38 87553	14.74 99551	0.809 97963	10.72 82182	1.970 11280	20.29 80745	14.94 65271	0.812 33700	11.62 31594	1.529 15889	16.61 92494	15.10 47606	0.873 21990	12.93 03703	0.394 91071	0.203 56689
1942	Steelhead	0.7525 50306	0.5955 9787	0.4482 17359	0.3668 54116	115.2 9	121.2 1	128.5 6	142.9 3	20.70 01528	27.68 78052	11.60 88268	169.0 67524	0.778 87656	10.96 21662	10.95 98985	11.46 24544	10.15 72065	81.79 23889	0.637 99482	9.011 22245	7.768 30201	22.67 06584	11.99 20921	210.3 30584	0.785 71663	10.19 91890	214.3 78463	0.459 20648	0.540 79351	0.678 95533	0.838 36013	0.884 27387	5.794 84718	23.91 37393	12.22 96432	0.819 34691	11.20 80654	2.016 89841	19.83 76367	12.52 03771	0.821 72548	12.23 97524	1.565 90216	16.23 64979	12.77 41279	0.870 81262	13.84 83133	0.535 24108	0.343 13256
1943	Steelhead	0.7578 99846	0.6092 31406	0.4617 36389	0.5376 99113	125.1 8	125.0 3	128.9 6	134.1 4	16.09 61590	31.55 39008	12.11 81979	232.5 23809	0.795 39189	13.92 91180	7.722 90268	15.80 79256	10.70 79435	117.1 25883	0.632 98378	13.25 87661	6.398 74886	28.11 20429	12.50 20424	297.1 72848	0.828 42803	12.58 30981	313.8 75183	0.302 66907	0.697 33092	0.681 92785	0.884 66939	0.884 71527	4.809 99921	29.64 64946	12.69 56216	0.840 57664	13.63 34426	1.614 14331	24.72 70933	12.97 07504	0.853 45339	14.30 92323	1.251 52289	20.27 56738	13.23 28705	0.870 66045	16.50 75774	0.564 22577	0.354 05598
1944	Steelhead	0.6832 25681	0.4953 41731	0.3384 30191	0.3345 35856	120	128.9 6	136.4	138.1 6	22.91 69086	26.64 49479	13.12 28015	126.8 96981	0.839 63595	10.62 62352	13.02 49459	9.614 42045	11.12 07986	54.30 45784	0.791 28158	9.606 63909	7.939 48568	21.45 49823	14.03 33714	162.3 99790	0.799 74932	9.605 93684	172.0 78369	0.435 25094	0.564 74905	0.583 85672	0.789 50759	0.844 70589	5.991 56178	22.41 17931	14.23 21529	0.825 84381	10.56 14358	2.129 98159	18.78 15562	14.42 82522	0.825 76666	11.39 05003	1.652 37484	15.40 56594	14.55 75113	0.884 97102	12.63 51780	0.438 61976	0.230 33910
1945	Steelhead	0.6895 68462	0.5659 05871	0.3902 30841	0.6585 39863	123.1 5	126.5	132.9	138.0 4	20.12 07435	28.96 92821	12.72 61779	189.4 75699	0.798 69426	11.64 35747	11.10 97685	11.54 13549	11.17 73555	81.07 82730	0.670 69543	9.807 74116	7.055 47736	25.32 69836	13.23 06281	242.0 66281	0.804 70724	10.89 14633	259.7 52441	0.184 37234	0.815 62765	0.649 09739	0.826 43532	0.871 24873	5.239 21476	26.81 14631	13.43 03838	0.826 66956	11.92 71991	1.778 14512	22.42 72472	13.69 85807	0.826 15556	12.88 76202	1.377 36190	18.42 70349	13.92 59595	0.848 40732	14.77 70233	0.480 36066	0.285 63092
1946	Steelhead	0.7796 445	0.6523 25217	0.5085 81768	0.4181 61776	118.9 8	119.8 5	125.2 7	133.2 9	16.40 38700	32.25 13393	11.53 40631	265.0 10017	0.792 88030	14.26 24231	8.319 87861	15.70 34322	10.14 76774	121.0 66215	0.615 01453	12.19 82696	6.096 14203	30.04 29155	11.84 61246	340.4 74604	0.837 54234	13.22 83955	352.0 66986	0.435 82456	0.564 17543	0.715 40882	0.860 04505	0.897 14785	4.558 30238	31.82 82105	12.04 38587	0.835 94541	14.38 96717	1.503 67041	26.51 50172	12.35 70458	0.857 80276	15.03 39915	1.164 32135	21.80 44490	12.64 38899	0.877 90823	17.75 29878	0.595 22165	0.396 17733
1947	Steelhead	0.5882 71409	0.5355 52208	0.3150 50052	0.5890 81235	135.3 3	125.8 8	129.3	139.5 8	16.87 78559	31.30 00578	13.84 53636	237.3 8																																					

Columbia River System Operations Environmental Impact Statement
Appendix E: Fish, Aquatic Macroinvertebrates, and Aquatic Habitat

Year	Species	InRivSurvSNK	InRivSurvLCol	InRivSurv	ProportionTransported	MedDayLGR	MedDayConfl	MedDayBONinriv	MedDayBONtrans	meanTravelTime	meanMigRate	meanTemp	meanFlow	meanFSpill	meanGas	SNKTravelTime	SNKMigRate	SNKTemp	SNKFlow	SNKFSpill	SNKGas	LCTravelTime	LCMigRate	LCTemp	LCFlow	LCFSpill	LCGas	BonFlow	propBONinriv	propBONtrans	JDAInRivSurv	DeschInRivSurv	BONinRivSurv	JDATime	JDAMigRate	JDATemp	JDAFSpill	JDAGas	DESTime	DESMigRate	DESTemp	DESFSpill	DESGas	BONTTime	BONMigRate	BONTemp	BONFSpill	BONGas	monte_q975	monte_q025	
1951	Steelhead	0.7533 61713	0.6065 88814	0.4569 80788	0.4446 75594	119.7 4	121.5 8	127.0 7	134.4 8	16.50 24062	31.54 84396 2	12.45 41217 9	246.0 03861	0.804 12735 3	13.70 00197 3	8.226 15049 8	14.95 36083	10.89 23742 3	106.7 10353 1	0.653 54058 7	11.64 68677 5	6.302 70770 9	28.79 56640 7	12.88 95284 3	315.6 48488 4	0.831 68054 6	12.74 68936 4	327.4 25933 8	0.385 03474 6	0.614 96525 4	0.678 55680 7	0.843 27097 3	0.883 51823 2	4.729 25976 7	30.42 70848 6	13.08 43456 3	0.837 11756 5	14.09 77676 4	1.573 85728 5	25.34 41475 4	13.39 76847 3	0.850 67290 1	14.75 17140 7	1.219 46341 5	20.81 09292 8	13.67 63701 4	0.866 80266 3	17.25 86140 6	0.554 58561 9	0.356 83410 8	
1952	Steelhead	0.8040 04466	0.6757 80551	0.5433 30581	0.6120 44523	118.6 5	119.6 1	125.1	134.9 9	15.14 03207	33.32 43390 7	11.14 96399 5	287.0 49983 4	0.763 70296 1	16.52 91184 7	7.019 30529 6	18.75 82000 1	9.873 93245 7	164.0 85247 8	0.536 03946 6	16.22 72392 3	6.134 13128 3	29.98 55983 3	11.33 58802 8	350.6 81050 6	0.835 27407 1	14.81 47168 2	358.9 09027 1	0.269 38233 6	0.730 61766 4	0.734 45864 3	0.868 44698 4	0.904 49467 8	4.566 66991 1	31.83 92410 9	11.57 87002 6	0.831 89860 6	15.65 23357 4	1.500 50604 3	26.58 24154 2	11.90 88223 8	0.855 17064 7	16.14 21518 3	1.162 36001 3	21.84 16208 5	12.22 66998 3	0.880 27331 2	18.45 67275 6	0.623 06900 9	0.441 69791 6	
1953	Steelhead	0.7448 01282	0.5637 96934	0.4199 16679	0.4721 82737	119.9 2	124.9 4	131.6 4	144.2 6	17.96 43626 8	30.33 65130 2	12.79 2	212.9 34337 6	0.803 14955 5	12.62 53855 9	9.354 96529 9	13.46 38451 1	10.94 55751 4	91.92 21694 9	0.667 96329 8	10.46 94709 8	6.662 22098 5	26.77 15779 3	13.57 84591 6	267.9 59838 9	0.817 37977 3	11.87 82492 5	279.7 96600 3	0.339 94829 6	0.660 05170 4	0.646 66347 7	0.826 87173 4	0.868 44698 6	0.904 49467 8	4.566 66991 1	31.83 92410 9	11.57 87002 6	0.831 89860 6	15.65 23357 4	1.500 50604 3	26.58 24154 2	11.90 88223 8	0.855 17064 7	16.14 21518 3	1.162 36001 3	21.84 16208 5	12.22 66998 3	0.880 27331 2	18.45 67275 6	0.623 06900 9	0.441 69791 6
1954	Steelhead	0.7702 37022	0.6288 08166	0.4843 31329	0.3546 37238	111.7 1	119.3 6	126.7 2	136.6	21.44 87530 1	28.22 81287 9	11.21 13729 2	203.8 07342 5	0.793 33514	12.06 19404 3	12.11 94272	11.11 09685 4	9.742 73891 4	89.01 22741 7	0.638 30194 3	9.478 22742 5	7.344 90405 8	24.44 43435 9	11.59 57530 3	253.5 53772	0.819 19721 8	11.45 81779 6	259.5 64941 4	0.490 45152 1	0.509 54847 9	0.705 26850 3	0.853 55697	0.892 41266 5	5.457 25559 4	25.89 25610 6	11.82 93478	0.845 79696 7	12.66 72035 2	1.856 10400 3	21.53 74319 3	12.12 68030 8	0.844 77162 4	13.98 55457 9	1.440 85111 5	17.62 24453	12.37 57467 4	0.858 54074 3	16.23 19183 4	0.581 00081 9	0.380 05317 2	
1955	Steelhead	0.7295 37538	0.5669 09329	0.4135 81636	0.5272 61556	120.6 4	127.1 3	134.2 1	136.4 7	21.15 07164 1	27.85 40196 3	12.29 65372 6	170.8 40381 6	0.806 13378 1	11.31 40856 2	11.67 94272	10.81 75467 8	10.64 42819 6	72.48 0867	0.711 3819	9.580 73501 6	7.508 49981	23.44 45498	12.89 25581	215.3 77571 1	0.788 16081	10.46 15825	229.1 05514 5	0.291 49593	0.708 50406	0.651 37371	0.824 33943	0.872 25311 3	5.599 08123 3	24.73 20369	13.11 43741	0.815 27091	11.45 43277	1.923 85585	20.72 29946	13.39 14562	0.816 82072	12.48 38333	1.489 12705	17.05 86211	13.60 37769	0.864 01301	14.09 72814	0.508 59791	0.313 68702	
1956	Steelhead	0.7860 69708	0.6709 58223	0.5274 19934	0.5673 89767	123.6 2	120.3 9	125.2 5	139.1 4	15.08 52564 4	33.68 96356 3	11.65 43061	313.9 54036	0.806 23892	17.71 34905	7.475 68414	17.23 20389	10.38 50847	145.9 20434	0.630 93565	14.96 33876	5.635 02890	31.90 94181	11.88 43652	403.3 09738	0.855 44493	17.77 64636	418.1 91589	0.302 70096	0.697 29903	0.729 77904	0.868 69570	0.903 27818	4.213 27824	33.72 31731	12.10 28284	0.852 57133	19.40 12626	1.375 59408	28.98 64154	12.39 79113	0.877 35056	19.58 86516	1.064 46225	23.88 19821	12.68 29304	0.893 72128	21.06 68458	0.617 69044	0.434 13282	
1957	Steelhead	0.7687 86514	0.6368 39432	0.4895 93567	0.4899 74784	115.5 8	118.4 8	125.7 6	141.8 7	18.09 96391 8	30.15 83781 1	11.58 21046	265.3 68900	0.774 92024	14.75 77698	9.202 64937	13.86 98597	10.30 83360	118.1 63279	0.579 79117	11.25 69452	6.924 69977	26.43 49904	11.81 33557	318.7 06446	0.824 98819	14.18 74066	329.0 74066	0.356 80774	0.643 19225	0.713 72568	0.860 40474	0.897 40474	5.071 77626	28.21 68573	12.02 36522	0.850 82471	15.60 36800	1.664 99372	23.90 33987	12.34 14427	0.858 44983	17.05 67197	1.287 29131	19.71 15688	12.64 86578	0.874 98912	19.23 50049	0.564 41235	0.405 27633	
1958	Steelhead	0.7337 40103	0.6085 91352	0.4465 47881	0.6052 39179	124.7 2	127.8 9	133.5 5	137.8 6	18.21 30042	30.93 01789	12.36 26636	257.1 36205	0.800 83882	14.61 20994	9.911 73908	13.19 59322	10.96 55843	113.5 32957	0.656 20971	12.30 79265	6.340 36325	28.60 94577	12.81 12438	321.5 79956	0.821 78321	13.67 21214	333.8 98284	0.242 50793	0.757 49206	0.682 97162	0.846 59721	0.887 13166	4.706 49313	30.35 62842	13.00 79963	0.836 00193	14.97 57720	1.561 11227	25.53 16659	13.23 11115	0.850 36941	15.95 20600	1.208 64059	20.99 83785	13.41 57881	0.871 66762	18.23 68788	0.539 74832	0.355 57992	
1959	Steelhead	0.7267 4395	0.5936 91606	0.4314 61783	0.3571 81176	114.6 4	119.2 8	124.8 8	138.9 5	20.86 86667	28.86 55796	12.23 79720	208.1 09665	0.798 56119	11.80 32420	11.86 45286	10.94 76804	10.60 46255	76.82 61947	0.658 90518	8.896 66614	7.031 11358	25.86 54937	12.68 21891	272.3 34027	0.814 22229	11.43 32383	282.2 87994	0.462 44182	0.537 55817	0.674 32274	0.839 88420	0.881 05031	5.204 30643	27.48 33513	12.89 06902	0.837 17345	12.88 61682	1.747 02723	22.85 03515	13.22 86570	0.839 74828	13.89 72415	1.354 71640	18.73 31319	13.52 49810	0.853 34208	16.06 79774	0.513 07170	0.339 78142	
1960	Steelhead	0.7503 85707	0.6066 58987	0.4552 28233	0.4068 81088	117.5 5	124.5 9	131.3	135.7 7	20.55 96677	28.57 63685	11.78 21246	193.4 88303	0.810 19569	11.58 41120	11.52 03478	10.83 35940	10.20 70713	75.69 18823	0.690 78064	9.284 07211	7.062 60957	25.34 52845	12.25 65320	251.3 19163	0.814 80621	10.96 28904	262.8 23272	0.423 40749	0.576 59250	0.686 92369	0.844 75507	0.884 23183	5.282 55202	26.76 57291	12.47 78511	0.847 13716	12.29 48602	1.795 62192	22.25 12805	12.77 99752	0.844 27217	13.59 81028	1.393 43925	18.21 60238	13.03 29113	0.850 45120	15.80 08856	0.556 79005	0.344 77835	
1961	Steelhead	0.7164 26172	0.5606 40474	0.4016 57509	0.3754 34001	120.6 6	127.0 2	133.8 3	142.5 5	19.20 45678	29.53 80961	12.88 2	210.0 33056	0.835 84571	12.72 30420	10.60 32684	11.44 74340	11.14 46165	70.00 91751	0.756 05914	10.06 05232	6.646 38419	26.71 86405	13.62 15022	275.4 19120	0.820 25754	12.18 63573	281.0 30708	0.429 80774	0.645 02039	0.827 29519	0.870 02885	4.997 96898	28.12 23783	13.80 02159	0.850 4	1.702 34012	23.50 45292	14.01 09084	0.851 39119	15.07 61499	1.323 09353	19.17 89961	14.16 87741	0.860 16830	0.487 79200	0.310 85916				
1962	Steelhead	0.7146 28671	0.5634 59246	0.4026 64133	0.6230 94224	128.7 4	133.2 4	138.4	135.5	17.01 88420	30.77 46556	12.95 06267	202.5 11514	0.798 10151	11.80 71027	8.594 75303	14.09 80806	11.41 47781	89.00 85037	0.656 36092	9.676 53369	6.465 04274	27.46 35585	13.58 15976	265.5 31260	0.815 26998	11.31 78699	273.7 79296	0.212 32722	0.787 77300	0.643 86309	0.825 97483	0.868 85401	4.887 7	28.83 83483	13.76 97685	0.839 07491	12.54 76610	1.676 21447	23.90 15802	13.96 11825	0.842 02901	13.40 95528	1.304 39858	19.45 32594	14.10 40840	0.850 82683	15.54 86993	0.509 79196	0.280 63018	
1963	Steelhead	0.6757 98544	0.5346 39835	0.3613 08822	0.6861 96665	131.0 3	130.0 7	136.9 3	142.4	18.20 37253	29.51 77867	13.27 84616	190.2 78169	0.791 00108	11.69 84018	9.268 58594	12.98 43558	11.75 14478	86.46 89239	0.638 46250	9.724 20717	6.989 1	25.24 00127	13.88 96878	236.8 45258	0.813 56306	10.89 94971	245.2 27233	0.155 33739	0.844 66260	0.622 74985	0.816 83157	0.862 87995	5.251 93157	26.54 95526	14.05 66776	0.845 54194	11.95 87768	1.808 37156	22.12 46106	14.25 20796	0.846 49145	13.19 84888	1.405 13169	18.06 57676	14.41 10417	0.864 84611	15.26 66854	0.464 73548	0.252 95675	
1964	Steelhead	0.7220 33576	0.5731 17199	0.4138 0986	0.6221 35637	128	130.8 5	137.2 7	141.7 1	19.01 75811	29.16 07886	12.70 35816	202.3 15789	0.803 90498	12.38 06467	10.00 34547	12.29 50646	11.08 82707	89.69 49615	0.659 40651	10.13 09864	7.063 45800	25.06 08060	13.21 05601	251.4 56672	0.826 27349	11.72 97558	261.5 67382	0.216 75566	0.783 24433																					

Columbia River System Operations Environmental Impact Statement
Appendix E: Fish, Aquatic Macroinvertebrates, and Aquatic Habitat

Year	Species	InRivSurvSNK	InRivSurvLCol	InRivSurv	ProportionTransported	MedDayLGR	MedDayConfl	MedDayBONinriv	MedDayBONtrans	meanTravelTime	meanMigRate	meanTemp	meanFlow	meanFSpill	meanGas	SNKTravelTime	SNKMigRate	SNKTemp	SNKFlow	SNKFSpill	SNKGas	LCTravelTime	LCMigRate	LCTemp	LCFlow	LCFSpill	LCGas	BonFlow	propBONinriv	propBONtrans	JDAInRivSurv	DeschInRivSurv	BONinRivSurv	JDATTime	JDAMigRate	JDATemp	JDAFSpill	JDAGas	DESTTime	DESMigRate	DESTemp	DESFSpill	DESGas	BONTTime	BONMigRate	BONTemp	BONFSpill	BONGas	monte_q975	monte_q025
1969	Steelhead	0.7221 50247	0.5818 50694	0.4201 83622	0.7410 86346	129.9 2	127.3 9	132.9 2	138.9	14.79 41462 5	33.19 03220 3	13.20 71242 3	271.7 36776 1	0.793 99121 9	15.39 62026 3	6.995 94606 5	16.86 27279 2	11.56 63871 8	122.0 79641 7	0.617 75333 5	12.91 18030 5	5.845 44735 4	30.69 17246 8	13.87 21952 4	342.8 10557 5	0.837 85135 5	14.78 04479 6	346.6 02050 8	0.137 39085 3	0.862 60914 7	0.655 12638 5	0.833 61780 5	0.875 38128	4.405 14152 5	32.32 07912	14.06 02472	0.842 63130 4	16.37 58459 1	1.470 39061	27.18 40104 1	14.27 47119 3	0.856 67210 8	16.95 15883 1	1.141 26139 1	22.25 00092 7	14.43 88780 6	0.872 25553 4	18.93 35131 6	0.524 14883 6	0.300 25902 7
1970	Steelhead	0.7193 24805	0.5823 46298	0.4188 96137	0.5424 59235	117.7 9	126.8 7	134.3 2	143.5 7	23.62 43993 1	26.91 95663 9	12.04 61049 1	177.9 52751 7	0.835 70061 4	12.21 93823 9	13.83 52978 2	9.02 18047 4	10.49 93856 4	73.81 08322 1	0.731 10547 1	10.41 95974 3	7.834 72819 6	22.57 16977 4	12.55 19830 4	214.2 41358 4	0.840 71351 1	11.23 28504 7	217.5 51803 6	0.281 53333 6	0.718 46666 4	0.666 18915 5	0.836 84804	0.878 14014	5.801 08542 7	23.89 23888 3	12.76 66269 3	0.870 51123 4	12.34 83387 3	1.996 66084 3	20.05 76468 4	13.02 8608	0.866 89255 6	13.84 37067 7	1.551 74504 2	16.38 17423 6	13.23 71635 4	0.878 47471 2	16.06 95176 1	0.509 09232 7	0.316 89753 5
1971	Steelhead	0.7270 28819	0.6303 06558	0.4582 51032	0.6971 25921	139.6 4	135.5 6	135.8 8	145	15.30 07508 7	33.77 21371 8	311.4 03921 8	177.9 28139 8	0.806 25256 9	17.67 00269 8	7.758 01681 7	16.63 04998 6	11.46 41504 3	142.2 21276 9	0.631 75722 4	14.54 48268 9	5.597 64179 6	32.11 44325 9	13.02 32296 1	394.7 44344 1	0.854 79195 9	17.61 40417 5	399.2 0.178 78005	0.821 21994 7	0.696 51172 4	0.855 39289 9	0.892 65882 6	4.179 18309 6	33.95 85886 9	13.19 34434 9	0.854 39888 2	19.33 08166 5	1.376 34547 1	29.01 72763 6	13.43 95017 6	0.875 91618 3	19.88 94933 1	1.066 78219 1	23.82 89723 9	13.68 19367 4	0.890 16214 1	21.44 97547 1	0.552 92845 5	0.352 39577 5	
1972	Steelhead	0.7611 86671	0.6273 60237	0.4775 3825	0.5118 14872	121.9 5	120.8 1	126.3 6	140.1 3	16.69 30214 8	31.55 64723 8	12.26 58361 7	277.1 20197 3	0.818 75528 6	15.74 80268 5	8.524 90121 1	14.48 38957 3	10.74 15741 4	116.9 75779 7	0.683 46246 5	12.94 09709 9	6.203 60266 8	29.06 78243 4	12.58 82495 7	351.5 42495 6	0.840 87711 6	15.33 345.2 2	0.331 36450 5	0.668 63549 5	0.696 68173 8	0.852 25326 7	0.889 97671 8	4.643 52620 4	30.71 47970 4	12.77 97517 8	0.845 52172 5	16.89 58179 4	1.551 02909 4	25.79 83692 6	13.13 18721 8	0.861 12276 7	17.43 91549 4	1.205 42255 8	21.05 48030 5	13.47 54447 9	0.873 08272 7	19.49 97782 7	0.555 04017 5	0.385 59045 3	
1973	Steelhead	0.6633 12602	0.5031 85916	0.3337 69559	0.3119 68709	116.1 9	126.0 3	133.5 6	146.6 7	24.01 88236 3	26.20 02931 9	13.00 26108 9	131.8 84109	0.838 40354	10.68 07385 5	13.88 76005 8	8.836 91641 2	11.12 87000 7	49.74 02175 9	0.781 07327 2	9.444 77176 7	8.186 23176 2	20.93 98601 5	13.78 3137	167.2 82351 2	0.805 38035 4	9.687 36449 9	175.3 34762 6	0.457 77450 6	0.542 22549 5	0.591 15096 7	0.792 36495 7	6.130 89695 1	21.96 78895 6	13.98 39023 6	0.828 62349 7	10.74 11472 3	2.167 90735 7	18.45 06728	14.21 72190 3	0.827 07178 4	11.60 82086 6	1.681 17722 9	15.14 86359 3	14.38 94515 3	0.881 18225 3	12.96 32682 8	0.411 98628 2	0.236 02465 4	
1974	Steelhead	0.7428 20333	0.6329 26216	0.4701 50463	0.5635 07228	133.5 7	128.8 8	129.5 2	141.6 6	15.50 02317 7	33.55 45252 4	12.64 73712 9	294.5 63508 2	0.820 61946 4	16.56 98849 1	7.987 15889 5	15.88 02298 3	11.09 91161 3	123.8 06784 1	0.670 19641 4	13.33 84323 1	5.560 47882 9	32.35 76774 2	13.01 21526 7	384.8 02500 4	0.856 28212 5	16.71 89463	393.7 02423 1	0.285 37896 6	0.714 62103 4	0.697 57416 5	0.853 34810 5	0.890 72412 5	4.173 52774	34.14 64666 6	13.20 19491 2	0.853 54499 8	18.32 75590 9	1.373 71557 2	29.05 64828 9	13.54 04313 4	0.874 68125 4	18.77 87148 2	1.064 12156 7	23.88 97370 4	13.85 47005 7	0.890 26537 5	20.42 11359 5	0.561 39924 3	0.369 70721 3
1975	Steelhead	0.7741 86475	0.6093 23855	0.4717 30287	0.3229 84759	112.8	122.0 3	129.3 1	137.2 3	21.33 02069 5	28.12 35910 9	11.55 25536 5	193.4 70744	0.810 63378 3	11.88 61114 6	11.96 78888 8	10.86 42917 9	9.859 15260 3	81.79 20059 2	0.692 13757 5	9.603 86467	7.384 76226 5	24.27 70405	12.05 03562 3	243.2 64279	0.814 69783	11.18 82309	250.9 75921	0.519 10034 7	0.480 89965 3	0.691 46499 3	0.846 46004 8	0.886 22441 5	5.486 38293 9	25.71 12461 8	12.28 53017 8	0.850 63918 8	12.39 62406 2	1.863 47737 3	21.45 49640 8	0.849 50643 8	13.82 52296 4	1.447 00596 5	17.54 83786	12.90 19198	0.863 66996	16.03 55587	0.574 41409	0.357 25674	
1976	Steelhead	0.7909 33445	0.6646 22617	0.5256 72256	0.5498 63847	114.9 9	116.7 8	123.4 2	136.9 9	18.27 05872 1	30.38 87109 2	11.00 87060	249.7 17948	0.764 72540	13.95 68218 8	9.488 12029 5	14.10 00284	9.727 82955 3	124.8 40408 2	0.542 78988 3	11.52 33318 3	6.796 24936	27.00 69080	11.17 55917	304.8 61185	0.832 03458	13.27 87816	304.0 69427	0.316 22160	0.683 77839	0.730 12496	0.865 70652	0.901 38294	5.031 07616	28.72 89113	11.42 05116	0.840 68468	14.54 05679	1.676 76901	23.84 38299	11.76 99362	0.846 98474	15.20 24567	1.302 23909	19.48 54705	12.10 34636	0.857 10582	17.58 84060	0.599 49875	0.433 57240
1977	Steelhead	0.6103 73529	0.4751 73981	0.2900 3362	0.1636 45011	122.0 5	129.3 8	135.9 9	133.8 3	22.06 50313 8	26.37 07649 6	13.61 74771 4	110.0 56789	0.860 7704	10.52 41955	12.01 61327	9.774 63104	12.16 39738	38.46 35932	0.840 04809	9.882 95574	8.093 59833	20.72 85774	14.25 57096	147.2 13406	0.808 42470	9.323 95533	153.0 37780	0.636 18281	0.363 81718	0.565 85548	0.778 32277	0.834 62170	6.157 6415	21.51 94971	14.39 96608	0.835 45872	10.43 90968	2.231 76503	17.97 30143	14.56 11995	0.834 37448	11.19 41611	1.734 586	14.69 54283	14.66 27200	0.891 26162	12.37 94587	0.376 94587	0.202 68406
1978	Steelhead	0.7102 58595	0.5804 05697	0.4122 38135	0.5851 59014	133.1 5	134.1 7	138.6 7	142.3 8	16.87 76976 4	30.82 13766 8	12.81 58264 2	209.4 46417 1	0.804 40719 6	12.35 36484 6	8.454 90448 9	14.35 93918 7	11.49 64201	94.38 10714 7	0.671 00449 8	10.66 30573 3	6.473 50454 3	27.19 24020	13.26 09624	268.0 54321	0.817 78001	11.56 02920	278.1 58111	0.243 14502	0.756 85497	0.657 31392	0.832 45325	0.875 71297	4.910 92121	28.47 44705	13.42 33013	0.832 76047	12.84 24404	1.693 68414	23.58 08067	13.61 84234	0.834 95801	13.39 7487	1.314 02029	19.31 10823	13.78 78370	0.848 91668	15.48 84305	0.511 20257	0.320 15943
1979	Steelhead	0.7429 57523	0.6034 20004	0.4483 15431	0.4812 35641	118.3 1	124.6 7	131.0 7	134.8 1	21.06 33772 5	28.40 96990 8	11.78 20662 3	192.7 12147	0.813 12147	11.98 15543	11.82 69083	11.02 7596	10.47 70641	79.82 79159	0.702 46204	10.29 01351	7.257 16370	24.83 72708	12.22 37965	246.4 18459	0.811 89833	11.09 7145	258.5 83679	0.348 34873	0.651 65126	0.683 67947	0.844 32859	0.885 11728	5.367 92153	26.36 69762	12.41 70633	0.837 04897	12.20 27624	1.815 78737	21.99 70841	12.64 03640	0.836 00908	13.25 6121	1.408 57511	18.02 19855	12.82 07998	0.850 16682	15.35 16540	0.544 61459	0.354 91626
1980	Steelhead	0.7522 39903	0.6224 62712	0.4682 4129	0.4054 18896	112.8 5	120.8 9	126.5 8	143.2 9	20.45 35222 6	30.81 82972 4	12.08 56370 9	249.5 68523 4	0.812 52219	13.68 35827 8	12.23 15538	11.87 37069	10.09 49504	92.33 79531	0.685 30825	10.32 19081	6.259 86020	29.46 97173	12.71 79584	328.5 46763	0.824 79507	13.49 37383	350.2 06726	0.432 09359	0.567 98172	0.692 18507	0.847 19134	4.608 89141	31.42 97645	12.96 73507	0.832 46508	15.01 53839	1.499 63988	26.51 20549	13.36 16037	0.849 51945	15.91 64155	1.157 87242	21.92 71505	13.66 78481	0.876 27902	17.90 14878	0.546 45389	0.370 83320	
1981	Steelhead	0.5888 64226	0.5188 79545	0.3055 49602	0.5534 53281	136.5 8	134.8 6	138.8 6	148.8 4	17.17 56175 8	30.51 52268 6	14.25 99725	206.5 01392	0.804 57664	12.41 99756	8.616 37777	13.83 97083	13.04 59833	87.31 24237	0.669 45045	10.26 13580	6.636 09509	26.47 47840	14.61 14687	262.6 25735	0.819 47042	11.59 95385	270.0 60882	0.221 99312	0.778 00687	0.606 50942	0.810 05158	0.857 54470	4.998 41123	27.80 39327	14.75 12052	0.841 08675	12.76 95402	1.726 51305	23.13 84823	14.96 58807	0.844 99323	13.82 82165	1.339 82165	18.94 40427	15.16 42918	0.862 59502	16.01 47399	0.393 15240	0.221 65476
1982	Steelhead	0.7413 11948	0.6113 1468	0.4531 74876	0.5492 27334	121.5 7	120.7 8	126.1 4	139.0 1	18.93 74055 1	30.																																							

Columbia River System Operations Environmental Impact Statement
Appendix E: Fish, Aquatic Macroinvertebrates, and Aquatic Habitat

Year	Species	InRivSurvSNK	InRivSurvLCol	InRivSurv	ProportionTransported	MedDayLGR	MedDayConfl	MedDayBONinriv	MedDayBONtrans	meanTravelTime	meanMigRate	meanTemp	meanFlow	meanFSpill	meanGas	SNKTravelTime	SNKMigRate	SNKTemp	SNKFlow	SNKFSpill	SNKGas	LCTravelTime	LCMigRate	LCTemp	LCFlow	LCFSpill	LCGas	BonFlow	propBONinriv	propBONtrans	JDAInRivSurv	DeschInRivSurv	BONinRivSurv	JDATTime	JDAMigRate	JDATemp	JDAFSpill	JDAGas	DESTTime	DESMigRate	DESTemp	DESFSpill	DESGas	BONTTime	BONMigRate	BONTemp	BONFSpill	BONGas	monte_q975	monte_q025
1987	Steelhead	0.4959 7824	0.4890 9762	0.2425 81777	0.2349 20944	132.1 7	129.4 8	131.3 2	132.6 1	18.99 05650 9	29.00 48734 8	14.20 25128 1	179.8 67694	0.843 05319 6	11.80 37438 7	10.15 50748	11.43 74064 5	13.25 74279 8	55.09 63302 6	0.784 94395	10.29 01573 2	6.875 25577 1	25.57 24396 2	14.52 24601 3	243.7 94860 8	0.813 00443 4	10.81 62335 6	249.0 64315 8	0.489 69770 5	0.510 30229 5	0.579 31810 5	0.796 46782	0.847 21554 7	5.174 2943	26.86 86517 6	14.63 28910 8	0.835 78331 5	12.18 1703	1.795 42381 3	22.29 60688 9	14.76 23554 9	0.839 70222 9	13.06 21372 9	1.395 82566 2	18.18 51488 7	14.89 55221 2	0.862 57222 3	15.06 86197 3	0.319 26788 1	0.169 77185
1988	Steelhead	0.6828 34008	0.5345 73638	0.3650 2506	0.4432 34908	130.3 2	135.5 6	141.3 9	141.6 1	19.79 76448 7	28.13 8158	12.90 93711 7	149.2 17418 9	0.812 1437	10.67 77324 3	10.59 01366 5	11.09 44327 9	11.48 56409 1	62.52 86277 8	0.736 65133 7	9.293 40457 9	7.258 31896 8	23.65 05029 9	13.50 68039 9	195.0 07741 3	0.781 12623 1	9.727 76373 2	200.9 88220 2	0.341 01062 9	0.658 98937 1	0.622 14002 4	0.810 66359 1	0.862 30080 9	5.513 06850 5	5.513 92235 8	13.68 09806 8	0.815 26392 7	10.81 75260 5	1.954 87756 3	20.48 39743 8	13.83 43938 2	0.816 90983	11.75 50795 9	1.519 40385 3	16.72 83251 3	13.94 94200 3	0.870 68409 3	13.14 71226 3	0.465 85922 7	0.272 79991 5
1989	Steelhead	0.7855 32555	0.6383 36749	0.5014 34297	0.3353 11017	113.5 6	119.3 1	125.8 8	131.1 4	18.26 42603 2	29.91 49034	11.19 99932 7	220.8 14862 9	0.766 90544 6	12.35 73405 4	9.423 25421 4	13.42 86467 8	9.723 13575 7	106.6 47509 8	0.567 06766 5	10.22 07340 2	6.843 75555 1	26.63 75077 1	11.58 10258 5	280.4 10258	0.816 88954 4	11.75 25412 2	286.0 27008	0.520 16224 9	0.479 83775	0.710 26391	0.855 04623 4	0.893 24857 3	5.101 64124 5	28.23 69301 1	11.79 64298 2	0.832 00267 6	12.96 38837 8	1.710 20887	23.40 00423 2	12.11 91387	0.837 56027 6	13.62 95379	1.329 39762 6	19.08 83251 3	12.38 94200 3	0.851 68409 3	15.88 71226 3	0.590 85922 7	0.380 74201 2
1990	Steelhead	0.4875 60926	0.4669 06143	0.2276 45191	0.3468 26081	137.6 9	134.6	134.2 2	147.4	17.47 98914 1	29.99 98137 9	14.92 75923 5	185.0 33289 8	0.812 58522 2	11.46 98749 6	8.841 69859 4	13.08 45048 5	13.76 57825 5	67.07 36343 4	0.727 70382 7	9.482 33871 5	6.709 30300	25.99 32937	15.16 07117	244.6 55560	0.789 61246	10.59 64168	249.6 90322	0.342 22902	0.657 77097	0.559 57320	0.786 16754	0.840 71358	5.089 24578	27.18 29953	15.29 47816	0.814 84311	11.89 05986	1.778 80786	22.49 75985	15.51 28367	0.819 11242	12.92 47484	1.382 56625	18.35 81854	15.76 11517	0.854 75131	14.76 3762	0.302 34147	0.155 54485
1991	Steelhead	0.6709 93203	0.5486 19763	0.3681 20132	0.2882 43086	118.8 6	125.3 6	131.6 4	146.7	21.55 86425	28.34 08391 8	13.01 29660 9	188.7 36580	0.835 52561 1	12.08 37083	12.61 29558	9.568 41888	11.28 30049	60.57 37197	0.757 35709	10.03 92374	6.998 58391	25.36 04936	13.64 42403	250.1 36446	0.818 42892	11.18 30948	244.5 67382	0.509 51734	0.490 48265	0.634 47700	0.821 20867	0.865 87104	5.245 48888	26.72 78645	13.82 68837	0.847 45893	12.58 13669	1.814 02665	22.13 45529	14.08 15521	0.851 02947	13.83 67226	1.414 22301	17.95 07175	14.29 91657	0.868 78210	15.96 46854	0.446 38690	0.275 40483
1992	Steelhead	0.5117 43271	0.4601 09896	0.2354 58143	0.3089 89501	132.0 4	132.7 5	135.1 4	135.1 7	18.88 74911 4	28.46 76111 3	14.40 88559	152.9 34526	0.822 59449	10.79 1387	9.749 11936	11.62 38797	13.34 91235	51.71 16241	0.770 19485	9.352 72827	7.186 50592	24.02 33688	14.83 23531	205.3 30446	0.777 55784	9.809 43230	207.9 06784	0.391 73928	0.608 26071	0.554 76347	0.778 82463	0.836 42626	5.450 30272	25.08 72707	14.93 64063	0.807 38366	11.04 38880	1.926 57021	20.80 03407	15.05 21589	11.87 94032	1.498 92003	16.95 63154	15.14 20909	0.866 74547	13.31 14111	0.325 88255	0.165 26642	
1993	Steelhead	0.7503 15359	0.6146 33988	0.4611 69321	0.5775 62146	117.2 7	123.4 6	131.1 4	138.9 5	21.43 31355 4	27.79 21221	11.52 25889	196.7 05774	0.818 14746	12.62 11421	11.74 56068	10.78 00714	10.28 24935	86.11 84845	0.690 99006	10.49 10173	7.714 61001	23.49 83654	11.80 17692	238.0 87880	11.75 18600	248.7 8576	0.269 20611	0.730 96308	0.697 61986	0.853 53297	0.892 18315	5.654 49897	25.04 54221	11.98 74080	0.862 61488	12.88 39176	1.893 46451	21.10 9431	12.24 91003	0.861 08515	14.41 60566	1.469 45453	17.28 37066	12.47 58687	0.873 67096	16.62 47148	0.547 57375	0.351 62393	
1994	Steelhead	0.5736 70144	0.4896 47215	0.2808 95989	0.3397 93654	127.3 1	128.7 3	133.4 4	137.3 1	21.29 61353	28.05 09900	13.67 94379	160.1 88610	0.813 88449	10.87 60375	12.15 10375	10.28 38994	12.06 16582	60.21 37603	0.730 58068	9.242 83313	7.193 73332	24.15 98973	14.29 2267	212.6 01837	0.790 24655	10.04 50600	219.6 06582	0.395 91724	0.604 08275	0.579 77274	0.792 13176	0.845 72746	5.426 27250	25.31 72607	14.47 11332	0.822 20070	11.24 03844	1.905 15532	21.00 67393	14.66 62400	0.823 48563	12.17 84644	1.480 27413	17.15 91559	14.84 44881	0.864 18178	13.75 37198	0.365 79471	0.191 98927
1995	Steelhead	0.7372 35197	0.5515 89898	0.4066 51487	0.5069 15569	115.1 5	122.4 4	129.4 6	137.1	20.64 07528 8	28.11 11194	12.55 57165	182.7 34893	0.806 01538	11.65 91352	11.13 54998	11.25 35628	10.60 44281	80.22 77313	0.673 06724	9.730 36003	7.544 18741	23.65 29851	13.28 02852	224.9 32324	0.819 81337	10.94 24355	235.7 06619	0.301 43791	0.698 56208	0.639 44149	0.822 01307	0.865 90361	5.604 17400	25.03 58011	13.50 41200	0.853 56464	11.99 08714	1.905 76000	20.95 85808	13.82 08554	0.847 65329	13.35 33512	1.477 92346	17.18 60496	14.06 64758	0.857 83472	15.48 99702	0.495 44923	0.310 14279
1996	Steelhead	0.7328 93276	0.6368 0444	0.4667 09692	0.4759 15943	121.7 5	118.6 4	123.2 2	144.2 7	17.24 34820 6	31.87 43143	12.18 51959	264.5 74298	0.787 80009	14.38 80273	9.090 58627	14.70 04475	10.86 23539	121.6 22000	0.601 55281	11.95 26454	6.193 05560	29.54 13117	12.26 27781	338.3 69608	0.836 90645	13.62 20143	350.7 25128	0.360 41471	0.639 58528	0.703 23878	0.855 04078	0.893 45387	4.613 49687	31.33 78308	12.48 90605	0.837 28289	14.98 36307	1.524 69831	26.14 26960	12.88 82039	0.856 75785	15.59 91382	1.180 38933	21.50 48046	13.28 09510	0.876 87292	18.06 90774	0.546 93202	0.387 77205
1997	Steelhead	0.7716 7632	0.6486 22209	0.5005 26399	0.6189 51149	133.7 2	125.1 7	128.5 9	142.3 2	13.83 78583	35.52 74795	12.66 91835	356.2 2052	0.820 93682	20.32 43678	6.712 50387	19.06 86766	11.09 86766	167.3 37817	0.658 86902	17.42 84370	5.174 78518	34.27 27980	12.03 24292	451.0 79645	0.866 46202	20.49 78313	451.7 92083	0.249 88306	0.750 02408	0.708 69329	0.859 96541	0.895 46134	3.890 46817	36.07 03974	13.23 29959	0.860 20026	22.37 21736	1.273 29047	31.36 50100	13.57 01745	0.889 16232	22.42 23626	0.985 87169	25.83 30003	13.89 29615	0.903 60733	23.50 98314	0.587 13484	0.393 02736
1998	Steelhead	0.7212 89002	0.5905 39297	0.4259 495	0.7483 71149	124.5 3	124.5	129.9 6	136.0 7	16.39 57145	32.40 68887	13.00 14698	265.1 37120	0.781 70192	14.32 81884	8.470 81967	14.99 81246	11.25 50910	116.9 35342	0.597 56189	11.41 32961	5.965 77214	30.52 36097	13.68 93541	341.0 35268	0.826 00307	13.91 88650	358.3 94409	0.135 56662	0.864 43337	0.664 77716	0.837 15853	0.879 12118	4.435 31381	32.38 46748	13.88 47560	0.532 55792	15.39 22012	1.456 70514	27.36 02361	14.15 13324	0.854 21175	16.31 31915	1.127 31915	22.52 87900	14.34 89399	0.881 06173	18.06 67676	0.526 23498	0.331 57136
1999	Steelhead	0.7201 90162	0.5886 67673	0.4239 52667	0.5948 44198	131.6 6	126.1 4	131.2	145.7 9	16.85 99147	31.25 13912	12.86 26026	234.7 89038	0.797 80920	13.27 45376	8.500 43870	14.53 12205	11.32 23024	104.3 51593	0.641 15325	10.74 89007	6.414 76844	27.97 53097	13.26 38152	297.8 39248	0.827 26080	12.69 57806	307.7 03613	0.241 32916	0.758 67083	0.666 03902	0.837 26277	0.878 30985	4.815 24191	29.50 99576	13.44 97713	0.843 21703	14.04 41638	1.622 18743	24.63 27887	13.77 04728	0.851 23054	14.95 87434	1.259 18242	20.15 20321	14.06 98308	0.863 61765	17.19 24605	0.520 11859	0.312 87300
2000	Steelhead	0.6187 46057	0.5487 45599	0.3395 34175	0.4348 76079	130.8 1	127.8 2	130.8 7	140.2 4	18.41 62937	30.29 71510	13.25 08682	202.2 54616	0.803 71850	11.93 48445	9.888 92354	13.24 48647	11.80 91217	90.25 23132	0.667 81704	9.992 88368	6.574 98706	26.95 06184	13.55 97101	265.2 22758	0.818 82911	11.42 37570	275.5 88073	0.338 25815	0.661 74184	0.628 93378	0.818 91607	4.964 99861	28.30 67132	13.74 63216	0.835 37193	12.65 72874	1.707 												

Columbia River System Operations Environmental Impact Statement
Appendix E: Fish, Aquatic Macroinvertebrates, and Aquatic Habitat

Year	Species	InRivSurvSNK	InRivSurvLCol	InRivSurv	ProportionTransported	MedDayLGR	MedDayConfl	MedDayBONinriv	MedDayBONtrans	meanTravelTime	meanMigRate	meanTemp	meanFlow	meanFSpill	meanGas	SNKTravelTime	SNKMigRate	SNKTemp	SNKFlow	SNKFSpill	SNKGas	LCTTravelTime	LCMigRate	LCTemp	LCFlow	LCFSpill	LCGas	BonFlow	propBONinriv	propBONtrans	JDAInRivSurv	DeschInRivSurv	BONinRivSurv	JDATTime	JDAMigRate	JDATemp	JDAFSpill	JDAGas	DESTTime	DESMigRate	DESTemp	DESFSpill	DESGas	BONTTime	BONMigRate	BONTemp	BONFSpill	BONGas	monte_q975	monte_q025
2005	Steelhead	0.6207 94024	0.5030 38364	0.3122 8321	0.5598 21432	126.1 1	127.5 9	133.9 2	141.5 8	18.39 19462	29.06 51379	13.97 45063	171.1 01148	0.796 46127	11.20 59750	9.355 23880	12.59 34165	12.55 62452	71.73 01773	0.688 86174	9.633 87966	7.097 95951	24.38 81616	14.42 63370	216.8 78570	0.784 35794	10.20 8781	224.9 50286	0.218 18007	0.781 81992	0.592 65365	0.796 65806	0.849 83265	5.375 14554	25.49 59499	14.60 10501	0.812 78160	11.31 13596	1.880 15400	21.24 21764	14.84 21351	0.813 46732	12.24 81800	1.458 08362	17.41 67405	15.04 67090	0.859 90011	13.84 90195	0.397 36004	0.226 00052
2006	Steelhead	0.7805 15883	0.6623 28474	0.5169 57894	0.4967 39286	114.2 6	114.8 3	121.0 5	135.9 3	17.71 90569	30.81 41173	11.08 77176	250.8 97943	0.757 29723	13.60 45002	9.008 01250	14.98 69489	9.826 82247	127.0 94087	0.520 13739	11.17 00868	6.718 65826	27.35 99043	11.25 55330	310.7 40341	0.833 57919	13.06 62113	315.6 63635	0.361 01046	0.638 98953	0.726 96303	0.864 56249	0.900 77285	4.967 75417	29.12 25215	11.49 38440	0.839 01879	14.26 28519	1.651 60494	24.17 46362	11.83 02733	0.849 15304	14.78 38312	1.281 03008	19.80 79240	12.15 55123	0.863 37712	17.06 38160	0.596 07395	0.426 90559
2007	Steelhead	0.6441 04922	0.5351 77481	0.3447 10449	0.3658 03161	117.3 5	123.4 6	129.7 3	136.4 3	19.33 75818	29.37 80521	13.45 22365	187.2 84271	0.837 06536	11.71 11275	10.65 02613	11.78 78962	11.91 59555	63.35 50582	0.767 77778	9.846 94309	6.729 38749	26.11 19280	14.04 99959	248.9 31098	0.813 33808	10.93 86318	258.8 13415	0.411 12422	0.588 87577	0.619 98085	0.814 21887	0.860 86436	5.081 21404	27.39 37453	14.20 51620	0.835 76940	12.23 01878	1.757 61014	22.73 60885	14.38 90206	0.833 42568	13.15 21228	1.364 25873	18.60 79240	14.53 55123	0.847 57036	15.16 37712	0.444 38160	0.239 30701
2008	Steelhead	0.7171 08404	0.5794 89793	0.4155 57001	0.5619 90346	123.6 6	126.7 4	133.9 8	143.5 3	19.80 72387	28.63 00934	12.64 72090	213.8 96670	0.823 99988	13.78 27414	10.56 54828	11.91 62516	11.07 67780	96.06 96960	0.693 81187	11.36 69656	7.294 43062	24.08 23559	13.06 85453	255.5 55859	0.844 49026	13.09 19265	263.3 86535	0.265 30771	0.734 69228	0.661 85631	0.834 82416	0.875 87539	5.438 99870	25.39 84346	13.28 11264	0.873 12707	14.27 33659	1.861 44767	21.43 20067	13.60 64233	0.872 28022	15.73 85765	1.442 11302	17.60 72369	13.89 72258	0.882 24604	17.98 86179	0.515 50398	0.319 25106
1929	Steelhead	0.7139 35307	0.5605 86262	0.4002 22325	0.0469 30781	130.3 5	138.0 8	143.5 2	138.7 6	19.50 11618	28.88 54058	13.11 26905	162.0 35650	0.978 93871	16.11 66727	10.59 95896	11.67 47456	11.58 24846	71.31 1409	0.974 63015	14.17 52073	6.957 87303	24.81 81977	13.79 47189	208.5 42177	0.971 99880	16.49 24340	218.7 35626	0.901 45624	0.098 54375	0.628 53471	0.816 82792	0.856 50235	5.272 22877	25.92 88654	13.95 75212	0.968 86363	18.64 67714	1.848 40428	21.64 03701	14.09 68472	0.966 05547	19.69 47447	1.435 75038	17.68 43709	14.17 84739	0.969 60040	20.95 80469	0.503 14321	0.282 18780
1930	Steelhead	0.5172 18311	0.4308 58498	0.2228 47905	0.0446 29186	142.2 1	143.6 6	144.9 2	145.9 8	17.43 36938	29.15 56093	15.00 36448	138.0 32017	0.977 23942	14.96 18308	8.412 31899	13.42 48647	13.58 02002	63.36 40861	0.976 24591	13.91 79433	7.092 60863	23.73 78561	15.67 37736	177.4 67053	0.966 68734	14.87 97387	182.7 99377	0.853 02567	0.146 97432	0.506 43605	0.753 81251	5.439 70643	24.55 87613	15.82 57290	0.963 18469	16.92 41188	1.965 10383	20.42 29859	15.88 49417	0.958 93307	17.83 57432	1.530 48247	16.60 51408	15.94 48556	0.963 54743	19.25 58183	0.325 27502	0.147 42998	
1931	Steelhead	0.5606 15917	0.4296 78703	0.2408 8472	0.0539 68333	139.3 5	144.1 1	147.4 4	144.7 1	16.96 88649	29.75 20613	15.14 26905	140.8 75250	0.977 19928	14.99 85171	13.59 92358	8.287 47977	13.36 22194	58.73 66470	0.974 70192	13.40 31086	6.765 01815	24.76 74561	15.99 52165	185.7 25100	0.967 88047	15.22 45817	188.7 05200	0.833 73244	0.166 26755	0.502 84717	0.748 70238	5.233 09050	25.48 12038	16.17 21782	0.964 02823	1.897 72506	21.16 64367	16.25 94160	0.959 94160	18.34 47650	1.479 5966	17.16 69358	16.30 02090	0.964 19608	19.69 05412	0.374 588	0.147 50546		
1932	Steelhead	0.7994 41645	0.6343 71441	0.5071 42948	0.0656 83591	121.1 7	129.3 7	134.7 9	138.2 9	16.80 21071	31.37 52290	12.29 00824	236.0 28579	0.974 71758	19.18 27247	8.611 36126	14.32 30731	10.70 63299	103.0 09513	0.973 72258	17.20 48461	6.218 33220	28.89 81494	12.91 03110	303.3 90568	19.69 55739	315.5 99273	0.886 91248	0.113 08751	0.695 38359	0.850 71561	4.659 81141	30.51 05330	13.09 98249	0.956 69971	22.27 72213	1.569 03212	25.41 72122	13.31 02610	0.955 44012	22.82 82756	1.215 48157	20.87 94870	13.47 40848	0.952 47265	23.33 35943	0.604 19377	0.368 08132		
1933	Steelhead	0.7284 80519	0.5742 60827	0.4183 37825	0.0636 75647	128.2 8	134.9 8	140.8 3	146.8 3	18.08 21481	30.32 52407	13.33 35792	206.8 61800	0.973 59100	17.35 19438	9.727 51333	12.56 51335	11.59 73175	75.41 37924	0.969 69201	14.33 23797	6.409 25154	27.46 42121	14.07 21627	271.6 68782	0.963 63596	18.24 97705	285.9 34387	0.872 95221	0.127 04778	0.642 66822	0.826 19914	0.864 35729	4.828 98578	28.84 71509	14.23 82177	0.958 39729	20.82 67677	1.652 91815	24.14 50864	14.42 41434	0.956 92044	21.72 56469	1.281 51046	19.80 04950	14.55 47523	0.956 49147	22.56 32829	0.514 33199	0.316 03212
1934	Steelhead	0.4633 72854	0.4892 16405	0.2266 89602	0.0521 14454	140.6 2	139.3 7	139.6 5	147.6 6	15.39 15636	31.97 35508	15.12 54150	204.1 97330	0.978 66412	17.58 93732	7.568 26039	14.46 89861	14.23 30753	57.84 83749	0.975 12588	13.47 84534	5.881 68507	29.66 21633	15.49 10138	284.5 76873	0.970 94494	19.32 21935	290.2 30773	0.836 28731	0.163 71268	0.565 85433	0.793 21598	0.838 15433	4.505 68419	30.87 45844	15.57 48992	0.966 01212	22.28 0439	1.570 80426	25.47 22786	15.62 19492	0.963 78250	22.65 67668	1.220 77968	20.78 83556	15.69 61002	0.961 01588	23.10 51197	0.307 90600	0.154 58377
1935	Steelhead	0.7184 60384	0.5555 39749	0.3991 33301	0.0416 07443	126.7 9	134.2 1	140.7 8	133.5 9	17.85 70531	29.87 20696	13.40 33721	179.9 03537	0.980 9458	16.82 65299	9.285 11041	12.73 64222	11.71 88028	69.76 40625	0.979 27538	14.52 42408	6.625 27338	26.28 57364	14.18 42192	236.4 82082	0.972 81082	17.35 52047	248.1 03363	0.911 67216	0.088 32783	0.625 09031	0.817 58118	0.857 09866	5.022 37025	27.49 37215	14.34 12843	0.968 90944	19.89 30591	1.743 84702	22.90 92178	14.47 42800	0.966 03947	20.87 72869	1.353 24624	18.75 33864	14.56 03938	0.966 90252	21.90 14864	0.276 91747	0.026 72904
1936	Steelhead	0.7048 58326	0.6155 58371	0.4338 81443	0.0528 32756	123.6 2	125.1 2	128.8 1	139.5 7	16.69 00173	31.42 92922	12.30 72653	234.7 05776	0.973 35662	19.62 80627	8.323 29742	15.57 48794	11.32 14918	118.8 86329	0.964 29078	18.04 46113	6.378 34659	28.24 18587	12.68 50601	294.5 98714	0.967 59014	20.09 3	305.0 70068	0.896 98492	0.103 01507	0.679 22357	0.846 13722	0.880 70694	4.754 99752	29.88 94027	12.84 25882	0.962 30642	22.31 46053	1.609 64950	24.79 69925	12.95 31873	0.959 97593	22.82 66563	1.248 07599	20.33 18367	13.05 26723	0.956 19806	23.31 24828	0.512 59805	0.340 58427
1937	Steelhead	0.7388 94775	0.5782 20107	0.4272 43816	0.0356 43643	121.0 1	131.3 9	137.4 4	130.8 3	21.75 98521	28.08 49841	12.65 10778	162.3 74629	0.978 39960	15.78 25698	12.65 93782	10.15 71633	10.90 02990	58.82 63092	0.972 31904	12.79 78223	7.137 96040	24.52 93990	13.40 86219	215.7 95839	0.972 66677	16.65 28873	226.9 01657	0.928 55504	0.071 44495	0.644 79708	0.823 37938	0.861 59454	5.351 65950	25.79 94188	13.59 96490	0.969 77521	19.08 55510	1.853 58554	21.55 61843	13.79 63161	0.967 23312	20.14 35731	1.438 22959	17.65 42171	13.93 32509	0.970 61738	21.37 42342	0.533 74096	0.304 15361
1938	Steelhead	0.7903 76185	0.6237 79144	0.4930 2018	0.0518 53015	122.8 9	127.4 2	131.5 4	146.0 1	15.49 08735	32.24 35109	12.47 36864	240.8 64812	0.972 69387	19.52 41119	7.405 49091	16.42 79292	11.12 32549	113.5 91824	0.970 74452	17.94 47761	6.108 44388	29.24 47290	13.01 48944	308.0 70841	0.960 66558	19.89 89341	318.6 06781	0.907 53142	0.092 46857	0.685 70517	0.846 67809	0.880 90916	4.600 37568	30.78 70129	13.17 22459	0.954 06682	22.34 52285	1.558 26370	25.61 99490	13.34 53559	0.953 68957	22.70 13994	1.208 37698	21.00 29973	13.48 88973	0.950 98510	23.25 78563	0.582 6672	0.371 52565
1939	Steelhead	0.5890 77942	0.5204 73493	0.3065 99454	0.0397 95808	138.6 8	140.9 8	143.7 7	146.2 7	16.77 36985	30.25 58645	13.80 69669																																						

Columbia River System Operations Environmental Impact Statement
Appendix E: Fish, Aquatic Macroinvertebrates, and Aquatic Habitat

Year	Species	InRivSurvSNK	InRivSurvLCol	InRivSurv	ProportionTransported	MedDayLGR	MedDayConfl	MedDayBONinriv	MedDayBONtrans	meanTravelTime	meanMigRate	meanTemp	meanFlow	meanFSpill	meanGas	SNKTravelTime	SNKMigRate	SNKTemp	SNKFlow	SNKFSpill	SNKGas	LCTTravelTime	LCMigRate	LCTemp	LCFlow	LCFSpill	LCGas	BonFlow	propBONinriv	propBONtrans	JDAInRivSurv	DeschInRivSurv	BONinRivSurv	JDATime	JDAMigRate	JDATemp	JDAFSpill	JDAGas	DESTime	DESMigRate	DESTemp	DESFSpill	DESGas	BONTTime	BONMigRate	BONTemp	BONFSpill	BONGas	monte_q975	monte_q025
1943	Steelhead	0.7840 65531	0.6035 30449	0.4732 07422	0.0561 02273	127.3 7	132.9 3	137.5 8	139.4 4	15.31 49785 7	31.97 12519 4	12.75 28501 2	228.5 14217 9	0.971 54620 7	19.05 44282	7.140 32699	16.32 52691 3	11.22 05970 8	111.8 40036	0.964 44737	17.72 04223 6	6.209 22536 4	28.50 59463 6	13.38 66910 9	288.8 29050 7	0.963 23507	19.26 03991	300.8 52844 2	0.896 45914 4	0.103 54085 6	0.666 57721 6	0.837 07974 5	0.872 96945 5	4.697 29787 9	29.91 14666 6	13.56 90229 4	0.957 16118 8	21.65 39127 3	1.601 98568 6	24.92 38790 3	13.75 32781	0.955 47688	22.13 75363 7	1.242 52774 6	20.42 29160 1	13.89 75958 8	0.953 06491 9	22.83 38975 9	0.579 61249 6	0.350 80056 7
1944	Steelhead	0.7096 34719	0.5416 90279	0.3844 02229	0.0391 68489	122.8 5	132.6 9	138.9 8	133.6 6	20.95 68917 3	28.24 30167	13.24 13671 4	152.5 21246 2	0.977 21573 3	15.37 22185 1	11.94 73953 6	10.41 18015 2	11.31 88474 7	56.92 34939 6	0.971 73613 3	12.80 83160 4	7.061 10099 7	14.13 09381 6	202.6 39180 5	0.970 39043 9	16.08 45660 4	210.4 67086 8	0.914 58804 1	0.085 41195 9	0.611 21708 4	0.807 84883 2	0.848 96016 6	5.342 80482 7	25.56 12269 6	14.32 15606 7	0.967 62788 3	18.40 86921 7	1.877 70766 8	21.32 06646 9	14.47 51993 8	0.964 51924 2	19.40 36483 8	1.459 54293 8	17.39 95425 1	14.57 44462 8	0.968 22497 2	20.66 31918	0.490 40862 6	0.275 39465 4	
1945	Steelhead	0.7417 25874	0.5630 54826	0.4176 32333	0.0379 70398	131.2 8	136.5 1	141.2 3	139.1 5	17.08 71939 7	30.85 71939 3	13.42 20947 5	194.0 10857 7	0.981 52209 6	17.98 19312 4	8.672 22253 2	14.50 13600 2	11.70 28190 6	91.39 09668	0.979 42338	16.21 28433 2	6.475 09381 2	27.01 61514 3	14.17 08405 8	246.4 04927 6	0.974 03262 1	18.33 82287 8	258.1 24438 2	0.920 83861 7	0.079 16138 3	0.631 07348 9	0.818 92149 1	0.857 75078 4	4.900 52089 9	28.29 46187 9	14.34 35960 8	0.970 51733 7	20.55 70575 7	1.693 74184 3	23.57 65392 2	14.52 08104 5	0.968 33668 2	21.53 78716 8	1.313 87676 3	19.31 31886 1	14.64 38126 6	0.969 35454 1	22.43 15729 1	0.527 12701 8	0.302 12286 3
1946	Steelhead	0.8064 74868	0.6481 19904	0.5226 92414	0.0306 36692	123.1 1	128.1 4	132.0 6	132.7 4	15.60 76025 7	32.65 36142 3	12.12 88790 7	258.6 21246 2	0.973 40369 2	19.98 54797	7.730 96833 4	15.90 90759	10.66 22100 8	111.2 58725	0.979 93700 5	18.20 26927 9	5.893 76156 8	30.72 99457 7	12.70 31209 3	0.954 66136 9	20.50 60757	347.8 55835	0.946 5061	0.053 4939	0.706 88360 7	0.856 82560 8	0.889 43817 6	4.419 45128 9	32.47 06614 4	12.88 52222 4	0.946 66194 9	23.11 43096 8	1.477 69460 8	26.99 82953 6	13.08 16370 2	0.946 51224 3	23.26 15833 3	1.144 81560 1	22.18 01268 7	13.22 87940 9	0.941 30149 5	23.64 05811 3	0.607 61734 7	0.403 08437 4	
1947	Steelhead	0.6276 28134	0.5360 31304	0.3364 28327	0.1027 29741	136.4 5	137.0 3	137.9 3	131.9 4	14.91 06232 7	32.93 41811 9	14.22 63073 9	242.8 56445	0.971 52110 1	19.54 48255	7.072 77201 1	16.93 90525	12.88 07478	113.3 85853 6	0.966 79515 8	17.93 37474 8	5.884 93792	30.03 44518	14.86 41715	309.9 00309	0.961 21998	19.92 96333	316.4 24438 5	0.772 36244 6	0.227 63755 4	0.607 19863	0.812 93830 9	0.854 38418	4.453 51115 6	31.50 40929	15.00 53819	0.954 65925	22.44 92557 5	1.529 9839	26.11 81412 3	15.08 04780	0.953 75458	22.81 63000	1.187 46044	21.37 56572	15.13 89026	0.949 92962	23.31 83345	0.430 40053	0.243 49396
1948	Steelhead	0.7776 39892	0.6254 63624	0.4863 85465	0.2059 62472	132.9 7	136.8 7	141.9 7	149.5 1	13.84 42249 4	35.01 40250 9	13.44 84054	346.8 08689 7	0.944 73400 3	22.47 04087	6.632 51669	18.19 32661	11.82 43913	145.8 34063	0.928 27132	19.43 37570	5.277 43357	33.52 64558	14.07 58811	433.0 82002	0.930 8	23.33 24438	448.8 51562	0.674 09327	0.325 90672	0.687 54199	0.849 68408	0.884 18429	3.966 28087	35.27 69379	14.25 22535	0.922 96376	26.11 34138	1.307 41266	30.54 68013	14.46 98924	0.938 35751	26.31 50042	1.012 5	25.13 57188	14.63 43836	0.937 79099	26.17 14153	0.588 62729	0.361 29720
1949	Steelhead	0.8061 9503	0.6256 05098	0.5043 59721	0.1139 03629	120.5 9	124.8 5	130.4 7	138.4 5	15.49 38141 1	32.63 70080 8	12.50 69211 6	265.0 30977	0.964 08483	20.15 32953	7.511 85044	16.69 00304	10.75 88787	126.9 87321	0.957 64937	18.72 02816	6.007 82302	29.89 80937	13.20 80362	332.1 78105	0.951 49014	20.41 98939	345.7 08618	0.809 51183	0.190 48816	0.687 15700	0.847 05479	0.881 33313	4.503 15108	31.56 13297	13.40 63766	0.944 08989	22.76 64226	1.502 87077	26.52 87077	13.63 23347	0.943 23347	23.11 71023	1.163 47417	21.82 4	13.79 90698	0.937 36833	23.61 54718	0.603 24060	0.391 73472
1950	Steelhead	0.7778 49409	0.6222 35716	0.4840 05684	0.0389 50729	125.1 7	133	138.4 1	138.2 4	17.44 81289	30.35 93511	12.24 80891	211.9 65554	0.979 34695	18.42 57940	8.888 80631	13.74 17029	10.91 27246	93.89 08218	0.981 14864	16.84 87129	6.587 23846	27.00 72303	12.79 95208	271.2 6179	0.967 51931	18.65 00624	286.0 83374	0.928 64161	0.071 35838	0.685 07019	0.846 96379	0.881 25303	4.936 94154	28.47 31785	12.96 25162	0.962 54891	21.12 64228	1.679 37877	23.75 54561	13.10 91110	0.959 8	21.88 71167	1.301 52400	19.49 61639	13.20 25947	0.958 90698	22.65 55147	0.576 94025	0.372 94401
1951	Steelhead	0.7788 20257	0.6155 8283	0.4794 28378	0.0375 95731	123.3 4	129.5 7	134.5 6	135.8 9	15.55 70248	32.43 57547	12.80 89983	249.4 48659	0.974 71365	19.58 57387	7.653 29076	15.64 32862	11.30 74562	103.1 17825	0.981 67789	17.68 13392	5.930 57175	30.28 51498	13.46 20118	325.4 00472	0.956 26712	20.07 21499	338.9 20898	0.930 19509	0.069 80490	0.679 24776	0.845 81835	0.880 62412	4.462 99202	31.91 67030	13.62 11311	0.948 85370	22.79 70813	1.497 81756	26.63 91908	13.77 37455	0.948 17698	23.09 25998	1.160 65950	21.87 39446	13.88 47923	0.943 24600	23.51 50737	0.582 91211	0.361 42244
1952	Steelhead	0.8281 41527	0.6679 41763	0.5531 50311	0.1725 53848	124.1 2	127.6 1	132.0 9	135.5 7	13.79 13409	34.54 09838	11.90 25462	288.9 53351	0.946 65672	20.94 56539	6.080 30784	10.69 19087	159.1 96130	0.917 69523	19.79 88498	5.726 25060	31.55 41495	12.37 25682	356.9 61761	0.944 12025	21.28 86530	368.0 28287	0.740 33556	0.259 66443	0.723 72052	0.865 09086	0.896 59190	4.298 27268	33.31 67719	12.54 89587	0.934 93126	23.34 73098	1.430 50506	27.90 83038	12.70 34594	0.936 54662	23.38 64816	1.108 75544	22.91 15403	12.81 54425	0.930 34356	23.70 98903	0.641 87805	0.432 63007	
1953	Steelhead	0.7790 61627	0.5974 80229	0.4654 7392	0.0549 36882	127.1 2	132.4 4	140.2 9	158.5	16.59 53270	31.48 41990	12.96 26389	222.8 70872	0.975 66442	18.57 97247	8.437 46674	14.53 74734	11.18 32881	95.13 76190	0.975 42959	16.49 47731	6.216 91422	28.44 97298	13.75 69527	285.1 93537	0.963 69274	19.02 78571	299.0 34942	0.897 73966	0.102 26034	0.662 56577	0.835 36478	0.871 55821	4.686 26730	29.89 65418	13.93 15736	0.958 31135	21.49 63176	1.591 97946	25.06 16563	14.11 53628	0.957 14495	0.957 47663	22.30 83569	1.233 73387	20.56 31073	0.956 1424	23.02 4	0.569 67797	0.330 67101
1954	Steelhead	0.8010 0964	0.6470 03322	0.5182 55898	0.0453 13271	116.4 2	126.1 7	132.4 4	140.8 7	19.26 25974	29.45 60017	11.61 11990	213.8 91323	0.975 96281	18.16 82619	10.47 04439	12.36 10512	10.21 92749	92.86 64505	0.977 36554	16.41 03263	6.806 50635	26.27 05008	12.16 00305	274.1 25315	0.962 77543	18.49 79589	286.2 50915	0.922 03791	0.077 96208	0.706 26246	0.855 38509	0.888 03662	5.070 37420	27.78 36761	12.34 72297	0.957 10791	20.85 01220	1.719 34072	23.21 31518	12.52 29883	0.954 92839	21.57 39739	1.333 00866	19.03 68028	12.63 93981	0.953 40436	22.44 85235	0.609 46836	0.409 41999
1955	Steelhead	0.7709 50769	0.5950 99527	0.4587 92438	0.0350 90394	125.2 6	132.6 4	138.7 9	140.5 2	17.96 91920	29.96 14637	12.72 79923	191.1 20970	0.980 09648	17.47 05743	9.310 10907	13.15 77924	11.11 74903	81.01 79290	0.979 33927	15.46 05159	6.705 94988	26.25 12957	13.40 73254	245.5 54753	0.970 77624	17.84 16702	259.2 75085	0.932 96764	0.067 03235	0.660 05910	0.832 56859	0.868 81469	5.041 17940	27.60 02724	13.59 26029	0.966 90852	20.23 39134	1.728 32079	23.08 88743	13.78 96502	0.964 69348	21.24 19948	1.339 74684	18.94 14462	13.93 23058	0.965 82299	22.24 09257	0.565 72718	0.335 79271
1956	Steelhead	0.8064 42204	0.6685 34988	0.5391 34829	0.1505 64372	128.1 5	132.2 3	136.9 4	147.6 7	14.15 03292	34.51 03003	12.25 94971	320.7 99924	0.942 29873	21.29 33927	6.782 79514	18.04 05179	10.97 19108	140.4 07788	0.928 77378	19.02 76313	5.399 87589	33.03 7711	12.69 60447	409.2 612	0.924 71920	21.67 43547	425.8 20068	0.767 73678	0.232 26321	0.724 40125	0.865 71613																		

Columbia River System Operations Environmental Impact Statement
Appendix E: Fish, Aquatic Macroinvertebrates, and Aquatic Habitat

Year	Species	InRivSurvSNK	InRivSurvLCol	InRivSurv	ProportionTransported	MedDayLGR	MedDayConfl	MedDayBONinriv	MedDayBONtrans	meanTravelTime	meanMigRate	meanTemp	meanFlow	meanFSpill	meanGas	SNKTravelTime	SNKMigRate	SNKTemp	SNKFlow	SNKFSpill	SNKGas	LCTravelTime	LCMigRate	LCTemp	LCFlow	LCFSpill	LCGas	BonFlow	propBONinriv	propBONtrans	JDAInRivSurv	DeschinRivSurv	BONinRivSurv	JDATTime	JDAMigRate	JDATemp	JDAFSpill	JDAGas	DESTTime	DESMigRate	DESTemp	DESFSpill	DESGas	BONTTime	BONMigRate	BONTemp	BONFSpill	BONGas	monte_q975	monte_q025
1961	Steelhead	0.7420 33208	0.5946 40003	0.4412 42629	0.0460 43318	124.1 5	132.8 4	140.1 5	140.9	18.04 60590 1	30.59 33503 2	13.00 46510 7	224.6 42682 8	0.970 67843 6	17.76 76269 3	9.898 33512 9	12.10 71463 3	11.27 79930 1	73.88 79333 5	0.974 58996 8	14.67 27470 4	6.197 00911 6	28.56 10653	13.80 51425 6	301.5 14048 3	0.952 75851 3	18.69 50096 3	312.2 52227 8	0.910 46331 4	0.089 53668 6	0.660 80916 4	0.836 03945 6	0.872 65458 9	4.662 36701 6	30.04 11906 3	13.96 54247 3	0.946 40904 7	21.42 73693 3	1.578 77868 4	25.30 87454 8	14.10 72584 8	0.948 20859	22.16 43797 6	1.225 36298 6	20.71 02060 3	14.20 48010 8	0.947 61249 4	22.81 70871 7	0.534 57918 6	0.329 14179 9
1962	Steelhead	0.7536 38726	0.5699 02567	0.4295 00644	0.0339 67557	130.4 8	136.9 1	142.7 5	136.3 9	15.83 74623 4	31.62 92260 5	13.47 29943 3	204.9 79111 3	0.981 84121 5	18.29 95347 3	7.662 55581 4	15.21 08373 3	11.74 69741 8	89.02 81265 3	0.984 90251 3	16.68 74355 3	6.233 82225 6	28.22 94272 1	14.22 87968 2	266.1 03256 2	0.970 21096 9	18.58 74564 6	272.9 19555 7	0.930 69449 5	0.069 30550 5	0.636 16990 4	0.822 01364 8	0.860 24838 4	4.729 77450 5	29.55 71385 8	14.42 00929 6	0.965 41035 2	21.17 81650 5	1.629 20984 6	24.56 14146 8	14.60 04400 3	0.963 86385	21.96 75299 3	1.266 36603 5	20.03 75085 5	14.72 61881 8	0.963 70980 1	22.64 97879 7	0.555 62580 4	0.283 97301 4
1963	Steelhead	0.7372 76549	0.5675 40787	0.4184 34513	0.0560 73012	134.3 1	140.8 5	146.4 5	146.1 6	15.67 36960 5	32.16 45818 2	13.67 12983 3	214.9 93238 7	0.978 67902 7	18.54 87940 7	7.660 27014 2	15.74 41522 2	12.06 86718 9	97.02 91854 9	0.978 80132 2	16.72 81448 4	6.080 23586 1	28.89 99527 3	14.40 85982 6	276.4 29715 5	0.967 91681 6	18.98 12896 8	284.8 2896 7	0.886 38123 3	0.113 61876 7	0.636 23181 5	0.824 39023 5	0.862 84238 8	4.616 82345 7	30.24 18641 8	14.54 94459 2	0.962 75416 6	21.41 22856 1	1.591 79986 3	25.12 50947 1	14.67 40859 3	0.961 01568 1	22.14 20739 5	1.236 60693 3	20.52 10559 9	20.52 72717 3	14.75 65609 7	0.959 27799 2	0.541 19097 3	0.303 19450 3
1964	Steelhead	0.7643 87827	0.5795 12829	0.4429 72552	0.0831 79626	132.0 8	138.6 7	143.9 2	145.1 9	16.29 27176 7	31.38 96571 2	13.36 02294 2	222.4 76891 7	0.971 50224 9	18.39 72174 1	8.029 48114 3	14.98 97631 7	11.60 31305 3	100.4 32612 6	0.969 66966 3	16.78 87432 1	6.325 04952 7	27.80 56977 1	14.11 52035 4	281.4 98710 6	0.958 75826 5	18.62 32829 1	294.0 23590 6	0.843 00423 6	0.156 99576 4	0.646 47510 5	0.828 18248 5	0.866 07113 9	4.765 85388 9	29.20 13946 1	14.29 59299 1	0.952 97969 6	20.91 42437 2	1.630 55641 2	24.48 04142 6	14.48 28955 3	0.952 02485 7	21.67 99049 4	1.264 37712 5	20.06 90788 9	14.61 56578 1	0.950 59859 8	22.42 48399 7	0.561 99568 5	0.317 17523 7
1965	Steelhead	0.7982 10951	0.6332 41406	0.5054 60224	0.1141 45046	130.9 4	134.9 9	139.5 2	152.0 4	15.66 00468 2	33.01 76036 6	12.54 72207 8	261.5 80171 3	0.964 31524 4	20.16 17762 7	7.816 90105 1	16.68 88023 8	11.04 32151 8	130.0 32151 8	0.955 18177 7	18.69 90921 9	5.885 10630 3	30.52 45547 9	13.13 66109 8	330.1 99640 9	0.954 08418 8	20.54 17086 6	337.8 16955 2	0.809 73721 2	0.190 26278 8	0.694 21630 5	0.851 37495 8	0.885 01625 5	4.414 85808	32.21 20210	13.30 24004	0.946 70263	22.83 44074	1.485 35437	26.90 16708	13.48 69063	0.947 65947	23.13 66259	1.152 59350	22.02 86872	13.63 00921	0.943 69983	23.53 15275	0.588 74614	0.404 73014
1966	Steelhead	0.6761 25177	0.5384 28221	0.3640 44876	0.0467 26444	131.1 5	137.0 6	142.3 1	138.2 3	16.98 55336 8	30.30 24647 6	13.75 44737 5	176.2 30718 3	0.982 00824	16.88 38504 7	8.558 65806 3	13.40 31056 6	12.24 94827 3	69.30 61218 3	0.979 24799 9	14.53 81938 9	6.485 50894 1	26.64 48053 9	14.41 53491 7	233.8 54011 5	0.975 31276 9	17.50 51074 8	239.2 64556 9	0.894 11398 2	0.105 88601 8	0.606 17367 4	0.805 69216 2	0.847 38479 2	4.952 65772 2	27.73 67342 6	14.60 04076	0.971 73731	20.16 02596	1.740 51155	23.00 15700	14.72 32554	0.969 67399	21.08 52286	1.353 39783	18.75 12987	14.78 19590	0.972 19505	22.05 0704	0.491 16613	0.233 91267
1967	Steelhead	0.7411 45937	0.6125 83161	0.4540 13521	0.1003 04005	133.9 4	140.6 8	145.2 3	147.7 7	18.27 40553 2	30.52 00396 4	12.85 86221 4	236.6 67664 1	0.962 89072 7	18.17 79155 4	10.08 71133 4	12.15 81211 8	11.43 38523 9	94.54 37088	0.959 57301 9	15.62 71362 3	6.243 59308 9	28.22 38937 4	13.45 18526 4	308.3 92344 2	0.947 10087 8	18.89 48181 1	316.7 29274 2	0.818 51710 7	0.181 48289 3	0.676 54303 5	0.843 77537 1	0.879 57249	4.687 06285	29.69 60969	13.60 49930	0.940 54796	21.34 34188	1.598 43408	24.99 76057	13.74 16874	0.943 53673	21.88 39035	1.240 65696	20.45 38151	13.83 77022	0.943 03149	22.55 07266	0.361 17439	
1968	Steelhead	0.6674 65779	0.5386 22647	0.3595 12185	0.0229 63916	120.7 6	126.5 2	132.3 2	141.6 2	22.30 30079 3	26.96 62929 7	13.24 02361 5	156.5 19409 9	0.972 90358	15.45 58377 6	12.61 63281 7	9.621 83804	11.78 10953	62.05 49781	0.971 32108	13.52 46866	7.722 33644	22.39 64562	13.87 42235	203.6 76483	0.960 67436	15.84 11125	213.6 75109	0.945 54401	0.054 45598	0.612 97006	0.810 12876	0.851 86354	5.771 86206	23.54 59216	14.00 53457	0.957 98293	18.09 89067	2.028 21699	19.72 04066	14.15 03480	0.954 55666	18.69 17508	1.574 09504	16.15 37098	14.24 93901	0.959 11502	19.77 82106	0.444 40756	0.260 55558
1969	Steelhead	0.7723 23208	0.6075 42494	0.4692 19168	0.1493 97258	132.7 3	136.5 9	141.5 1	140.3 6	13.27 05956 2	35.39 19172 7	13.56 15727 6	293.8 93128	0.953 14391	20.52 65028	6.063 86968	19.35 26168	12.00 77770	131.3 94857	0.952 30145	18.86 03946	5.263 26523	33.59 78197	14.29 05047	379.6 41464	0.930 41801	20.95 80456	385.7 18712	0.744 15425	0.255 84574	0.671 06668	0.842 44818	0.878 62363	3.991 23916	35.21 15606	14.44 84840	0.920 61470	23.46 90868	1.336 36596	29.94 47295	14.56 79636	0.925 32793	23.55 08562	1.037 4844	24.51 62037	14.64 70537	0.919 28398	23.71 66309	0.589 03020	0.327 2659
1970	Steelhead	0.7699 41779	0.6187 11763	0.4763 72036	0.1020 64304	124.1 4	133.0 2	139.8 5	150.0 3	18.99 70113 4	29.97 49174 5	12.41 54924	212.2 12733	0.968 71295	17.84 04950	10.45 36578	12.40 07071	10.93 54066	95.13 20205	0.959 25433	15.61 12606	6.593 53922	26.86 40178	13.03 84787	269.2 95160	0.960 95160	18.45 77829	276.6 60797	0.822 04672	0.177 95327	0.681 97082	0.844 03481	0.878 83395	4.933 21487	28.32 57443	13.20 42991	0.956 06509	20.68 00018	1.686 30151	23.70 48939	13.37 61351	0.955 06721	21.43 86609	1.309 41511	19.37 88583	13.49 62344	0.955 09687	22.22 79272	0.570 28339	0.350 80939
1971	Steelhead	0.7735 36607	0.6289 15873	0.4864 89451	0.2365 01614	140.1 8	144.6 5	147.9 5	149.1 5	13.34 94674 3	35.83 89981 4	13.29 92441 3	322.4 80913	0.935 77278	21.28 38640	6.310 33399	19.38 73066	11.88 76861	147.6 02923	0.920 59716	19.33 30776	5.099 07192	34.55 50298	13.89 48976	415.0 56137	0.916 30557	21.74 39955	420.3 52569	0.631 23135	0.368 76864	0.690 33761	0.886 28308	3.857 87326	36.23 34004	14.03 13850	0.907 91924	24.06 90666	1.282 43634	31.19 59062	14.16 32728	0.921 34547	24.12 17810	0.994 81345	25.59 43998	14.25 81744	0.919 01102	24.34 95826	0.590 48831	0.375 33850	
1972	Steelhead	0.7937 14101	0.6372 7296	0.5058 12534	0.1133 51161	127.7 8	131	135.9 4	148.4 7	14.85 48850 9	33.59 62428 1	12.71 77603	299.6 32839	0.954 17539	20.84 88748	7.335 43875	16.62 32838	11.15 89843	125.2 05116	0.955 20980	18.66 34849	5.554 66701	32.03 89755	13.35 14336	389.4 62488	0.930 40125	21.36 17633	389.4 27993	0.811 72006	0.188 31846	0.698 88324	0.853 72437	4.177 11748	33.73 20654	13.50 32350	0.923 25412	23.93 78185	1.391 01874	28.75 56457	13.67 64005	0.936 11596	24.06 48791	1.079 92133	23.53 36591	13.82 07812	0.936 05393	24.34 26008	0.590 59486	0.403 93541	
1973	Steelhead	0.6916 3276	0.5447 80908	0.3767 88323	0.0315 79168	118.7 4	130.3 2	137.0 5	141.8 5	22.18 23939 3	27.77 77438 5	13.14 36273	150.4 22299	0.975 41533	15.21 67547	13.03 43582	9.598 83253	11.23 83253	54.04 24026	0.968 93529	12.55 64231	7.202 42249	23.99 66121	14.01 61618	199.9 49531	0.968 52359	15.98 59215	207.8 264	0.930 06579	0.069 93188	0.614 22194	0.808 24958	0.849 17346	5.427 32965	25.13 71175	14.19 94829	0.966 23330	18.33 15612	1.905 20244	21.00 78145	14.36 93513	0.962 99123	19.21 87423	1.480 41715	17.15 75287	14.48 45652	0.966 98042	20.41 67661	0.474 52499	0.272 83707
1974	Steelhead	0.7751 31282	0.6259 64475	0.4852 04646	0.1162 06777	134.7 3	139.6 7	143.5 1	137.1 2	14.01 63504 5	34.85 20025 5	13.18 91818	302.9 26807	0.950 85672	20.82 41024																																			

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Appendix E: Fish, Aquatic Macroinvertebrates, and Aquatic Habitat

Year	Species	InRivSurvSNK	InRivSurvLCol	InRivSurv	ProportionTransported	MedDayLGR	MedDayConfl	MedDayBONinriv	MedDayBONtrans	meanTravelTime	meanMigRate	meanTemp	meanFlow	meanFSpill	meanGas	SNKTravelTime	SNKMigRate	SNKTemp	SNKFlow	SNKFSpill	SNKGas	LCTravelTime	LCMigRate	LCTemp	LCFlow	LCFSpill	LCGas	BonFlow	propBONinriv	propBONtrans	JDAInRivSurv	DeschInRivSurv	BONinRivSurv	JDATime	JDAMigRate	JDATemp	JDAFSpill	JDAGas	DESTime	DESMigRate	DESTemp	DESFSpill	DESGas	BONTTime	BONMigRate	BONTemp	BONFSpill	BONGas	monte_q975	monte_q025
1979	Steelhead	0.7785 27583	0.6202 56325	0.4828 86657	0.0351 08822	122.8 6	130.4 6	136.5 4	140.0 9	18.69 72970 1	29.70 66013 5	12.20 04006 2	196.8 40798	0.980 19299 3	17.82 79008	9.950 37756 9	12.76 40475	10.80 75992 6	85.86 60263 1	0.978 84900 6	15.77 27703 1	6.776 89330 3	26.26 47876 1	12.78 55607 7	253.3 32962	0.971 40989 7	18.31 49326 6	264.5 16143 8	0.935 60121 3	0.064 39878 7	0.683 27674 4	0.844 81970 2	0.879 09080 3	5.060 55955 6	27.73 36675 8	12.95 65574 6	0.967 48570 2	20.72 82138 6	1.726 56525 7	23.13 00019	13.11 09085 1	0.965 14457 5	21.58 24260 7	1.339 38939 9	18.94 64744 2	13.21 34075 2	0.965 50434 8	22.38 32578 7	0.577 14710 7	0.368 82846
1980	Steelhead	0.7919 4571	0.6340 59873	0.5021 40996	0.0305 28025	116.9 1	125.5 3	129.9 6	146.0 6	18.12 14759 8	31.71 03698 7	12.37 61092 6	247.1 26093 7	0.973 76074 5	19.18 93840 9	10.16 91379 9	13.53 26084 6	10.51 16317 7	97.12 56759 6	0.979 79666	16.57 59605	5.986 47052 8	30.23 08656 9	13.13 06818 3	323.7 51002	0.955 61166 6	20.07 71373 9	337.9 85443 1	0.945 08704	0.054 91296	0.694 72355 5	0.849 94823 4	0.883 60075 9	4.457 15243 4	32.03 02179 6	13.33 36298	0.948 36305 4	22.67 02476 5	1.485 71647	26.83 79780 6	13.57 57687 9	23.12 26006 2	1.150 32585 9	22.07 44666 1	13.74 02713 6	0.942 12495 6	23.52 41139 3	0.595 38699 4	0.394 46412	
1981	Steelhead	0.6388 59387	0.5309 2634	0.3391 87276	0.0541 49765	139.5 6	143.3 9	147.8 2	152.3 8	15.25 63956 5	32.48 53197 7	14.66 03008	218.7 26740 2	0.975 92584 2	18.47 85310 9	7.368 03823 7	16.01 1353	13.36 58788 7	94.88 65387	0.976 19733 8	16.46 25362 4	5.968 38142	29.19 06604 2	15.25 86546 8	0.963 66277 3	19.01 78885 5	290.6 83013 9	0.870 09255 5	0.129 90744 5	0.129 28337	0.604 45055 1	0.810 28337	0.851 95340 8	4.545 20370 1	30.46 83701 1	15.36 01573 9	0.958 06431 8	21.49 75963 6	1.579 41305 6	25.31 05608 1	15.45 68548 2	0.957 92154 5	22.04 30698 4	1.226 42046 2	20.69 22493 7	15.52 37302 8	0.957 47029 8	0.431 67690 9	0.234 02183	
1982	Steelhead	0.7766 19711	0.6136 51991	0.4765 74232	0.0661 40221	128.1 6	132.3	137.6 7	147.4 6	16.28 07373 4	32.05 50764 6	12.75 81138 6	251.6 74137 7	0.970 12182 2	19.71 46768 2	8.245 92246 9	15.31 96741	11.21 07172	112.0 90379 3	0.973 45023 2	18.08 85795	6.071 10039 1	29.51 13135	13.40 85566 4	323.9 66140 7	0.952 40918 8	20.05 49617 6	329.9 23767 3	0.879 62742 3	0.120 37257	0.677 91094 2	0.844 23217	0.879 26504 5	4.539 80509 2	31.17 22388 2	13.56 41996	0.945 88208	22.49 35535 4	1.527 74507	26.15 99893	13.72 57849	0.948 35877 4	22.96 19229	1.185 87286	21.40 45188	13.84 84268 2	0.946 30751	23.39 45179	0.564 75603	0.372 77257
1983	Steelhead	0.7850 10201	0.6090 95816	0.4781 46429	0.0996 13225	127.4 1	130.2	136.0 2	152.7	16.89 37921 6	31.37 48909 9	12.72 34721 2	236.1 54670	0.969 62004	19.05 00153	8.673 62306	14.49 86409	11.04 64931	106.8 26808	0.963 51305	17.16 97135	6.266 30607	28.44 44300	13.44 16290	299.7 29909	0.959 51934	19.43 01095	306.6 01379	0.825 49212	0.174 50787	0.673 45988	0.840 70935	0.875 90303	4.692 61398	30.00 62444	13.61 05257	0.953 79028	21.86 92977	1.588 42082	25.15 66516	13.79 08436	0.954 21147	22.54 40031	1.232 93827	20.58 23673	13.92 66905	0.952 84399	23.15 29836	0.563 06010	0.369 54492
1984	Steelhead	0.8078 53755	0.6203 88733	0.5011 83368	0.1089 60489	125.4	130.7 9	135.9 4	144.9 1	16.33 18449 4	31.29 50043	12.25 75608	223.1 66320	0.972 50382	19.43 16669	7.725 67401	16.19 91482	10.74 89734	125.2 27719	0.958 68506	18.58 28060	6.635 68046	27.11 65606	12.79 23224	272.2 79314	0.970 27137	19.46 27299	279.8 03405	0.816 26326	0.183 73673	0.683 46502	0.844 71574	0.878 70567	4.942 69004	38.70 36195	12.97 60959	0.965 59696	21.39 62875	1.672 77650	23.89 83837	13.20 42786	0.963 89611	22.20 08355	1.299 01687	19.53 37484	13.39 45727	0.962 90475	22.90 33231	0.587 36048	0.393 10963
1985	Steelhead	0.7886 24505	0.6177 27879	0.4871 55342	0.0253 44631	123.7 5	130.5	136.5 3	135.8 3	17.19 12773 6	29.92 47146 3	12.13 67926	193.2 15732	0.980 72591	17.93 77313	8.330 62306	14.18 86409	10.79 64931	94.58 26808	0.980 51305	16.94 97135	6.882 30607	25.71 44300	12.67 16290	244.1 29909	0.971 51934	17.88 01095	253.2 01379	0.953 49212	0.046 50787	0.679 45988	0.842 70935	0.877 90303	5.167 61398	27.07 62444	12.86 05257	0.966 79028	20.16 92977	1.776 42082	22.50 66516	13.79 08436	0.954 21147	22.54 40031	1.232 93827	20.58 23673	13.92 66905	0.952 84399	23.15 29836	0.563 06010	0.369 54492
1986	Steelhead	0.7758 2288	0.5929 15758	0.4599 9761	0.0718 45482	127.6 1	130.6 1	135.6 7	153.1 3	16.25 51280	31.11 39432	12.81 19077	217.7 64632	0.974 94732	18.81 97120	7.755 77519	15.52 91702	11.17 62203	107.8 51762	0.971 51279	17.79 07283	6.536 10940	27.13 32986	13.47 39888	272.9 73866	0.965 28314	18.84 36418	276.2 82653	0.866 99787	0.133 00212	0.658 54649	0.832 91363	0.869 36185	4.910 79659	28.56 39645	13.64 75910	0.960 10603	21.12 46616	1.682 67294	23.78 32207	13.83 89883	0.959 28100	21.88 73818	1.308 03448	19.39 92734	13.99 47347	0.959 35851	22.63 79432	0.539 88116	0.357 35074
1987	Steelhead	0.5246 1044	0.5164 34694	0.2709 27032	0.0437 86532	131.5 7	131.0 9	134.0 9	145.1	18.37 83351	29.61 87113	14.30 11370	181.8 17509	0.978 10168	16.55 19630	9.828 77814	11.75 77562	13.25 35390	54.71 82128	0.972 73331	13.04 23255	6.593 72677	26.66 45493	14.69 43558	250.5 98864	0.971 62653	17.81 44733	256.0 71624	0.877 77464	0.122 22536	0.591 72892	0.803 30250	0.845 76156	4.964 76282	28.01 04219	14.82 07639	0.967 66902	20.67 02800	1.722 93951	23.23 29351	14.93 34427	0.965 24073	21.39 26175	1.339 59104	18.94 36392	15.03 99174	0.965 08845	22.15 83137	0.352 86568	0.193 18494
1988	Steelhead	0.7132 86669	0.5639 74289	0.4022 75342	0.0464 86464	132.6 5	139.7 3	145.1	136.5 4	18.27 6612	29.46 42422	13.21 23449	164.1 35812	0.980 91401	16.23 17513	9.653 12165	12.03 40490	11.70 56066	64.33 49266	0.977 87143	14.08 02988	6.683 61802	25.80 47489	13.89 27674	217.9 58859	0.973 90694	16.72 73537	223.3 02429	0.902 77022	0.097 22977	0.630 12014	0.817 14218	0.856 41644	5.092 94994	26.88 26721	14.06 17200	0.970 39187	19.24 02149	1.794 25908	22.32 85998	14.19 67671	0.967 72949	20.25 98946	1.395 98946	18.18 30451	14.27 13460	0.970 41538	21.39 22386	0.501 53336	0.288 37474
1989	Steelhead	0.8108 08627	0.6398 70182	0.5188 12263	0.0234 74949	115.8 4	124.2 6	129.9	133.1 4	17.47 28392	30.28 53140	11.74 61103	213.3 36930	0.980 53449	18.73 80729	8.859 49690	13.64 54835	10.22 29167	97.03 41033	0.981 74125	17.21 55166	6.621 47335	27.23 65421	12.31 71428	276.1 60261	0.969 52596	19.02 87330	281.4 06701	0.959 79189	0.040 20810	0.699 75769	0.850 07520	0.883 04379	4.944 04650	28.81 91553	12.51 10261	0.964 91455	21.64 53064	1.672 79249	23.91 97050	12.74 43214	0.963 78988	22.27 20097	1.299 08883	19.52 32869	19.52 81307	0.962 81473	22.87 98771	0.615 82381	0.382 87671
1990	Steelhead	0.5117 92289	0.4777 10255	0.2444 88425	0.0400 79333	138.8 9	138.8 9	139.9 4	142.8 9	16.15 81831	31.02 14215	15.08 87018	190.6 87018	0.979 93123	17.14 35047	7.901 30188	14.30 80492	14.04 73133	70.06 41021	0.979 17631	14.46 07765	6.315 72660	27.56 65421	15.55 2	256.2 60261	0.970 52596	17.95 87330	260.8 06701	0.875 79189	0.124 20810	0.555 75769	0.787 07520	0.833 04379	4.802 04650	28.78 91553	15.66 10261	0.965 91455	20.71 53064	1.680 79249	23.81 97050	15.71 43214	0.964 78988	21.53 20097	1.307 08883	19.41 32869	15.76 81307	0.965 81473	22.33 98771	0.335 82381	0.159 87671
1991	Steelhead	0.7044 15791	0.5713 48359	0.4024 66806	0.0312 83004	124.5 1	131.5 7	137.1 6	141.6 4	19.82 52350	29.44 37245	13.17 74648	194.0 70871	0.976 37374	16.96 07666	11.34 57181	10.72 08709	11.40 41448	67.35 96160	0.976 58726	14.10 81312	6.526 70402	27.06 93576	13.97 64512	263.9 13187	0.964 38305	17.97 56928	262.3 75183	0.933 39037	0.066 60962	0.639 73049	0.824 10588	0.862 35216	4.911 27140	28.46 27953	14.13 49140	0.958 75350	20.67 66321	1.700 66321	23.59 48494	14.29 31362	0.958 31362	21.29 11249	1.325 33390	19.14 66739	14.40 52677	0.958 65923	21.98 04821	0.480 22913	0.307 23045
1992	Steelhead	0.5406 5041	0.4909 329	0.2654 23074	0.0513 10774	132.0 3	134.6 3	138.6	140.6 7	18.09 55339	29.29 62792	14.59 11735	159.9 85929	0.978 07861	15.62 86982	9.344 68806	12.04 93045	13.41 21570	50.74 05777	0.970 76621	12.38 77697	6.806 43153	25.47 74512	15.07 30142	219.2 02850	0.973 21204	16.73 79569	222.0 72982	0.855 32833	0.144 67166	0.567 53706	0.788 29767	0.833 20860	5.161 01014	26.62 57824	15.20 02843	0.970 10541													

Columbia River System Operations Environmental Impact Statement
Appendix E: Fish, Aquatic Macroinvertebrates, and Aquatic Habitat

Year	Species	InRivSurvSNK	InRivSurvLCol	InRivSurv	ProportionTransported	MedDayLGR	MedDayConfl	MedDayBONinriv	MedDayBONtrans	meanTravelTime	meanMigRate	meanTemp	meanFlow	meanFSpill	meanGas	SNKTravelTime	SNKMigRate	SNKTemp	SNKFlow	SNKFSpill	SNKGas	LCTravelTime	LCMigRate	LCTemp	LCFlow	LCFSpill	LCGas	BonFlow	propBONinriv	propBONtrans	JDAInRivSurv	DeschInRivSurv	BONInRivSurv	JDATTime	JDAMigRate	JDATemp	JDAFSpill	JDAGas	DESTTime	DESMigRate	DESTemp	DESFSpill	DESGas	BONTTime	BONMigRate	BONTemp	BONFSpill	BONGas	monte_q975	monte_q025
1997	Steelhead	0.7939 3359	0.6476 15514	0.5141 63709	0.2666 67673	134.5 2	135.2 2	138.7 1	143.4 2	12.65 38598 2	36.97 18737 3	13.12 70932 5	366.6 26904 1	0.918 99256 6	22.55 51229 2	5.874 49822 6	20.78 38460 6	11.61 03775	166.0 41751 1	0.893 97580 6	20.05 73242 2	4.829 38502 7	36.20 16517 1	13.73 18015 1	471.9 14978	0.899 33653 7	23.20 70140 8	476.6 84783 9	0.605 01525 1	0.394 98474 9	0.705 50815 1	0.857 42878	0.891 76335 2	3.654 67511 1	37.91 31788	13.89 33845 5	0.890 79119	25.48 85051 7	1.198 09037 4	33.37 33274 6	14.06 38783 8	0.916 71427 1	25.27 16465	0.927 77565 1	27.50 31362 6	14.20 60928 3	0.919 03191 8	25.41 21570 6	0.605 88569 4	0.406 64397 9
1998	Steelhead	0.7805 05285	0.6058 35434	0.4728 57758	0.1468 30473	129.8 8	133.7 8	138.7 3	136.6 1	14.18 22347 2	34.48 35012 6	13.40 52533 4	275.1 11733	0.960 29286 3	20.20 96786 5	6.721 90143 2	18.47 97924 9	11.74 36504 4	130.2 77812 2	0.954 64291 6	18.51 23432 2	5.510 32942 5	32.31 54718 6	14.16 34534 2	351.5 11311 8	0.945 14793 2	20.69 62753 9	360.3 44574	0.749 92497 8	0.250 07502 2	0.670 38297	0.841 90176 3	0.877 91469 3	4.167 94163	33.94 03667	14.31 89416 9	0.936 19375 2	1.402 46039 6	28.50 64938	14.46 48383 5	0.938 01236 2	23.30 22015 9	1.088 34457 4	23.34 82702 5	14.56 24337 2	0.933 03176 8	23.60 79950 3	0.595 49624 6	0.343 19837 3	
1999	Steelhead	0.7553 83416	0.5916 07129	0.4468 90213	0.1103 84	134.4 2	140.2 6	145.8 2	150.5 2	15.12 96515 8	32.86 28160 9	13.39 8361	247.7 32253 5	0.966 26235 3	19.27 47906 6	7.296 2211	16.55 29578 9	11.78 99087 9	111.9 38792 4	0.961 65133 7	17.45 82233 4	5.893 58480 3	29.96 84761	14.07 10762 3	316.1 63940 4	0.953 23638 1	19.68 69739 7	326.7 41088	0.799 77551	0.200 22449	0.657 91119 6	0.834 95207 5	0.871 88879 7	4.458 96919 1	31.43 50074 3	14.21 83843 6	0.946 12714 1	22.10 43010 7	1.514 79628 7	14.38 30153 1	0.946 98217 5	22.62 98217 8	1.175 31561 9	21.59 84629 7	14.50 98891 3	0.942 75745 7	23.19 9646	0.545 56111 3	0.334 08162 6	
2000	Steelhead	0.6448 05252	0.5396 48884	0.3479 68435	0.0278 27265	132.1 3	134.0 8	137.8 4	140.0 5	16.93 53262	30.70 24190 1	13.56 89507 9	195.3 63778 8	0.982 92272 9	18.05 64297 6	8.514 45879	14.41 43654 5	12.24 50538 6	87.82 24807 7	0.983 94104 2	16.41 04621 9	6.460 96118 5	27.04 72428 7	14.14 88866 8	252.5 81507 4	0.973 53573 6	18.36 32514 5	261.4 14764	0.933 39642 6	0.066 60357 6	0.609 43646 1	0.810 74975 2	0.851 81522 3	4.899 67914 7	28.29 68152 4	14.29 47090 1	0.969 40058 5	20.85 42282 1	1.702 36932 5	23.48 10983 6	14.39 20335 8	0.966 96362 9	21.58 53029 9	1.321 87318 1	19.19 66494 1	14.47 48659 1	0.967 2243	22.46 93412 8	0.437 29811 4	0.261 80982 7
2001	Steelhead	0.6820 3293	0.5153 27132	0.3514 70074	0.0468 69272	132.3 3	138.0 8	143.3 2	143.5 9	18.73 41783 1	28.90 46468 7	13.77 92342 7	146.4 03543	0.976 67968 3	15.23 17863 9	9.844 96296 7	12.01 49924 7	12.01 28274 9	59.82 14538 6	0.973 54164 2	13.38 95540 2	6.956 76255 2	24.38 89696 2	14.61 39466	192.3 72884 1	0.967 63480 7	15.57 48227 4	199.1 4742	0.890 80122 6	0.109 19877 4	0.585 74772	0.794 23863	0.838 17055 6	5.325 89149 4	25.28 43886 4	14.77 74099 3	0.964 38713 1	17.78 30545 4	1.902 12383 9	21.07 56141 2	14.90 07450 7	0.960 71767 8	18.71 58870 7	1.480 28132 8	17.15 90933 8	14.98 40464 6	0.965 27594 3	19.98 25229 6	0.461 37637 4	0.243 69812 6
2002	Steelhead	0.7506 37282	0.5895 30862	0.4425 23844	0.0385 25794	125.2 1	132.9 8	138.5 4	137.4 4	18.26 85395	29.76 37088 1	12.81 14954	197.3 46836	0.977 29188	17.34 15728	9.711 36142	12.42 71175	11.14 21536	78.51 14538	0.978 24128	15.23 53490	6.598 83844	26.48 60147	13.51 11762	258.9 22991	0.965 14684	17.83 18087	269.0 19561	0.924 31895	0.075 68104	0.653 87919	0.829 46154	0.866 66880	4.987 98083	27.75 13653	13.69 99177	0.960 10253	20.35 22308	1.726 19666	23.13 16492	13.89 35639	0.958 04905	21.09 18490	1.338 91820	18.95 31180	14.03 73668	0.957 84387	22.02 95963	0.538 73390	0.327 04015
2003	Steelhead	0.7504 83912	0.5854 52694	0.4393 72828	0.0653 2111	126.9 7	133.7 3	140.4 4	149.0 6	17.15 62153 7	30.60 53251 1	13.04 12289	210.2 40107	0.975 44142	17.83 10549	8.805 34213	13.52 47012	11.39 96515	83.10 51361	0.973 81975	15.50 32897	6.400 39157	27.40 37918	13.79 2202	271.0 10348	0.964 51399	18.28 63670	289.8 63128	0.875 04601	0.124 95398	0.651 93114	0.831 04372	0.868 42232	4.836 07339	28.73 27478	13.95 05361	0.959 24565	20.83 41976	1.654 78639	24.06 04990	14.09 40233	0.957 05336	21.74 35315	1.279 91919	19.82 51217	14.19 60678	0.956 40137	22.69 68383	0.542 16886	0.327 11848
2004	Steelhead	0.7246 14176	0.5441 4291	0.3942 93666	0.0369 84625	131.9 8	138.5 2	144.1 5	140.0 6	16.68 19949	30.79 99465	13.72 59843	185.8 37983	0.982 95661	17.50 79876	8.340 16610	14.36 16222	11.99 65589	80.90 69610	0.981 92093	15.51 87120	6.409 05737	26.86 161931	14.54 27507	237.6 27507	0.975 29830	17.75 89092	257.2 84484	0.919 7267	0.080 2733	0.612 70957	0.811 15434	0.852 10633	4.898 26905	27.93 44832	14.70 88586	0.971 67847	20.16 56536	1.707 56056	23.31 91840	14.83 01957	0.969 48613	21.22 17903	1.320 84295	19.21 15864	14.90 84410	0.972 06196	22.42 42010	0.500 71581	0.273 69278
2005	Steelhead	0.6606 57111	0.5226 0951	0.3452 65689	0.0415 0243	131.9 7	136.2 6	140.6 1	142.4 9	16.14 86366	31.13 40728	14.37 62684	185.7 46113	0.980 90636	17.37 95592	7.833 70892	15.11 40265	13.01 11244	84.02 14538	0.978 33116	15.44 58259	6.381 11817	27.03 13038	14.98 24194	239.4 40485	0.973 50575	17.85 17373	245.6 02096	0.900 54247	0.099 45753	0.595 18164	0.802 03814	0.844 30855	4.877 70962	28.11 75545	15.11 48223	0.969 62400	20.23 21800	1.713 99828	23.34 07907	15.23 76912	0.966 97354	21.05 18411	1.331 92815	19.05 05814	15.32 93976	0.967 10638	22.02 96263	0.453 45291	0.229 4
2006	Steelhead	0.8165 63543	0.6638 75474	0.5420 96509	0.1095 63114	122.2 3	125.1 3	129.8 5	142.1	15.50 95171	32.40 44313	11.69 23960	265.1 42902	0.964 55093	20.39 63663	7.314 89060	17.27 40776	10.49 83760	132.9 51940	0.955 83943	19.02 48767	6.201 27082	29.18 04735	12.11 64563	329.9 75880	0.954 08622	20.67 41010	339.5 34668	0.827 25930	0.172 74069	0.721 19132	0.863 50412	0.894 78275	4.614 57467	30.92 33207	12.29 56903	0.947 69957	22.86 80740	1.540 41648	25.90 10329	12.46 65826	0.948 33467	23.26 11770	1.193 76734	21.26 18621	12.60 11714	0.944 40493	23.70 85924	0.629 99183	0.430 15774
2007	Steelhead	0.6742 45785	0.5490 18895	0.3701 73676	0.0264 21712	120.4 6	126.6 8	132.7 1	147.1 6	18.16 21347	29.95 63229	13.64 82026	183.2 60841	0.980 71361	16.87 51508	9.627 3681	12.93 96450	12.12 79794	68.40 06759	0.977 36194	13.97 74766	6.580 88142	26.43 40414	14.32 04906	242.5 78267	0.973 86399	17.77 55042	251.2 59460	0.939 85402	0.060 14597	0.619 61266	0.814 69873	0.854 77121	4.994 89862	4.994 57611	14.46 42572	0.969 92067	20.36 19442	1.740 44180	22.94 91983	14.59 51582	0.967 30937	21.19 90299	1.350 33438	18.79 36155	0.968 68581	22.16 36441	0.464 05291	0.250 93006	
2008	Steelhead	0.7537 27217	0.5866 10556	0.4421 44342	0.1230 34442	130.0 7	134.4 4	140.2 2	145.8 6	17.03 93362	30.97 40392	13.25 81944	239.3 46475	0.959 41868	18.40 01823	8.677 76413	14.49 16508	11																																

7 Table 4-6. Snake River MO3 Steelhead Raw Data

Year	Species	InRivSurvSNK	InRivSurvLCol	InRivSurv	MedDayLGR	MedDayConfl	MedDayBON	SAR	TotalReturn	meanGas	SNKTravelTime	SNKMigRate	SNKTemp	SNKFlow	SNKFSpill	SNKGas	LCTravelTime	LCMigRate	LCTemp	LCFlow	LCFSpill	LCGas	BonFlow	monte_q975	monte_q025
SCN MO3-RESSIM-GRNIMN																									
1929	Steelhead	0.909564749	0.542766236	0.493681035	132.73	136.93	143.31	0.01855251	9150.437077	10.22482531	9.137801051	10.4682683	11.67113132	69.35019684	0.98776015	0.861444092	7.507311143	22.76190546	13.75526714	180.2208761	0.948329101	15.11096573	191.8394775	0.62420504	0.360657245
1930	Steelhead	0.926676095	0.369231732	0.342158219	144.19	147.75	148.99	0.016167148	5526.983348	10.07119199	7.281026013	12.38910056	14.40856266	62.97882919	0.990560615	0.970558167	6.977151908	23.71119485	16.70770009	162.7431056	0.955918968	14.83666197	167.3792725	0.582626394	0.199376832
1931	Steelhead	0.934027342	0.403512819	0.376892006	140.21	143.72	147.18	0.017240195	6491.69309	10.09913608	6.3390949	13.86728934	13.30142288	58.34773483	0.991528475	0.990086746	7.087652311	23.404866	16.11866395	160.1384786	0.958140651	14.9367458	164.866394	0.603851964	0.226105864
1932	Steelhead	0.907325014	0.62050481	0.562999536	127.15	131.5	136.56	0.020881222	11746.6019	12.21347083	9.308955155	10.65597423	11.10763969	103.9789078	0.987256587	1.159049511	6.020127103	29.86121749	13.27374919	312.2877045	0.8980124	17.93769423	325.9284668	0.689461951	0.431677076
1933	Steelhead	0.905172103	0.563129923	0.509729497	131.87	136.55	143.17	0.018662695	9503.381236	11.87865141	9.616449326	10.02617395	11.85776367	74.49445496	0.992156088	1.116535759	6.391892962	27.43120428	14.26893934	266.3291245	0.926443358	17.56554635	280.4266357	0.632306122	0.366821075
1934	Steelhead	0.925517113	0.403561165	0.373502765	142.72	146.23	146.51	0.017155703	6401.425912	11.79347556	7.369450241	12.14710745	15.385602	54.3878891	0.990684056	1.243886185	5.715486638	29.94229174	17.07281367	269.2361857	0.918352534	17.60106182	274.084198	0.62340569	0.221065867

Columbia River System Operations Environmental Impact Statement
Appendix E: Fish, Aquatic Macroinvertebrates, and Aquatic Habitat

Year	Species	InRivSurvSNK	InRivSurvLCol	InRivSurv	MedDayLGR	MedDayConfl	MedDayBON	SAR	TotalReturn	meanGas	SNKTravelTime	SNKMigRate	SNKTemp	SNKFlow	SNKFSpill	SNKGas	LCTravelTime	LCMigRate	LCTemp	LCFlow	LCFSpill	LCGas	BonFlow	monte_q975	monte_q025
1935	Steelhead	0.917671655	0.548197375	0.503065193	129.7	133.76	140.56	0.019518732	9809.848575	11.32932983	8.116183974	11.48267223	11.92925167	68.32539825	0.994471729	1.078274727	6.624377757	26.25661041	14.28988934	234.8296916	0.939024707	16.8893067	246.7285767	0.642577798	0.355267715
1936	Steelhead	0.901571739	0.535652089	0.482928785	130.27	134.84	135.41	0.02006703	9681.298907	11.9545908	10.21486856	9.685783702	12.39217873	113.0710236	0.985799038	1.194895935	6.068328641	29.14099994	14.09718895	291.7525126	0.904025167	17.68399779	303.2958984	0.614777393	0.368422778
1937	Steelhead	0.889539613	0.563624014	0.501365888	125.46	130.4	137.35	0.020823101	10430.31412	10.44886596	11.44434023	8.519565841	10.9604845	57.98252029	0.987440443	0.867823219	7.681829527	22.62700797	13.36412843	183.8172709	0.953231235	15.48380136	196.7193604	0.637522003	0.352415475
1938	Steelhead	0.909194076	0.597049777	0.542834121	127.9	132.46	137.28	0.020125539	10914.39707	12.02330674	9.136208996	10.61466108	11.34512253	110.6820206	0.985078371	1.1548466096	6.073015779	29.09505825	13.66076581	295.1972453	0.906953752	17.74946451	303.9030762	0.663582276	0.405069363
1939	Steelhead	0.928260073	0.450334851	0.418027861	140.54	143.97	144.67	0.01788771	7470.793131	11.07573601	7.096021861	12.66786773	13.36241493	73.80453644	0.993551672	1.142361355	6.607821934	25.6511904	15.11769994	206.3823217	0.947502464	16.56767114	212.351532	0.584634991	0.291686601
1940	Steelhead	0.912230139	0.459409573	0.419087259	134.51	138.45	139.69	0.019045426	7972.590089	11.38372547	8.890903927	10.68177518	13.23808231	79.98398132	0.994157362	1.162361431	6.45670259	26.56537414	15.5065678	227.5396779	0.941748679	17.05405315	234.8130646	0.589450759	0.292327886
1941	Steelhead	0.918779706	0.485349001	0.445928812	133.45	137.14	142.05	0.018224632	8120.005961	10.71765014	7.900640331	11.72467994	13.44554119	59.88870697	0.993696249	0.943393707	6.919246592	24.59416539	15.23832782	192.953949	0.955375801	16.00019725	199.8234558	0.610707347	0.294407937
1942	Steelhead	0.890360111	0.598059933	0.532488709	128.14	133.39	140.01	0.01923253	10231.37495	10.97140912	11.36375075	8.878060812	10.95773525	84.05287323	0.992204976	0.988109207	7.067908011	24.67632579	13.01371876	221.7825216	0.93910561	16.26482773	231.3687744	0.654078924	0.409443564
1943	Steelhead	0.921696955	0.587172841	0.541195419	129.71	133.32	138.87	0.020196901	10920.5354	11.77734453	7.764792755	11.98501629	11.25463886	107.7869141	0.989335716	1.143270588	6.297411367	27.8459172	13.7430253	272.4194336	0.918300201	17.45914793	282.0322571	0.675610924	0.380454257
1944	Steelhead	0.897414665	0.50971598	0.457426595	127.82	132.61	139.87	0.019718874	9012.051896	9.952669655	10.42211574	9.454885397	11.42744942	56.55797882	0.986839271	0.864962769	7.745246753	21.89262635	14.19998503	158.9702861	0.955857317	14.6916705	167.1107635	0.597693788	0.323081923
1945	Steelhead	0.920434965	0.560816802	0.516195394	132.95	136.43	141.14	0.019132029	9865.864112	11.34450272	7.854712427	12.07933657	11.82983036	89.82672729	0.993010008	1.039020729	6.565493338	26.66914563	14.11833302	243.3911387	0.933451374	16.88381879	256.249402	0.646875384	0.377524257
1946	Steelhead	0.906391875	0.620943033	0.56281772	127.8	131.66	136.11	0.021139708	11887.42706	12.49517352	9.511859827	10.39788838	11.06581211	109.8943268	0.97717663	1.153513145	5.685735427	31.71038577	13.41253519	342.9023081	0.87824587	18.18872833	354.7502747	0.691400827	0.437147292
1947	Steelhead	0.927936674	0.48108188	0.44641352	137.93	141.34	142.04	0.018427712	8217.798375	12.06330603	7.283183686	12.67068549	115.3757095	0.979874718	1.203177547	1.203177547	5.603525288	31.22844397	15.81276989	310.6450958	0.889811993	17.78660695	317.7140198	0.630534175	0.300097125
1948	Steelhead	0.940150798	0.620736771	0.583586171	136.04	139.16	143.96	0.018065131	10533.29782	15.85914353	5.832487233	15.46851019	12.07530155	152.4988129	0.981677401	1.452693558	5.004723579	36.48440233	14.33501911	459.9104716	0.862883012	23.60676384	481.7173157	0.712099936	0.444880636
1949	Steelhead	0.908730179	0.592151898	0.5381063	126.88	131.14	136.27	0.020860653	11213.67762	12.82011584	9.242641166	10.80269242	11.41090069	130.9932587	0.980542314	1.188987923	5.679472022	31.72942436	14.03853814	347.9525299	0.881387949	18.48584811	366.4682922	0.66199674	0.40354398
1950	Steelhead	0.907047571	0.604985922	0.548751011	129.48	133.77	139.48	0.019795396	10850.88224	11.75214314	9.528647177	10.09230541	11.36313629	91.95399628	0.990817404	1.084252644	6.464893386	27.45144895	13.30808846	274.5722427	0.917227934	17.33497985	292.0809021	0.679523519	0.417665131
1951	Steelhead	0.909803746	0.587610205	0.534609966	127.76	131.55	136.96	0.020680349	11044.0101	12.44457023	9.11501196	10.59220732	11.56968536	102.1277481	0.984214318	1.192652225	5.776962183	31.09899868	14.09695625	328.9064433	0.888326536	18.12170998	344.8418274	0.662110146	0.390356321
1952	Steelhead	0.925172405	0.642459101	0.594385431	128.64	131.93	136.51	0.020791977	12345.53421	12.65889798	7.436487384	12.79171634	11.08562412	158.3066315	0.971980381	1.107407856	5.579759479	32.44952333	12.94071563	358.4302928	0.868903389	18.28395335	369.9718628	0.697857916	0.464629256
1953	Steelhead	0.918768576	0.591443761	0.543399942	132.17	136.57	143.8	0.018031213	9789.802732	11.93057735	7.987603411	11.92864483	11.48774452	94.86805573	0.99095943	1.09791851	6.149263494	28.7975048	13.85478465	285.9973246	0.91432934	17.53193188	300.5162354	0.679871267	0.421508509
1954	Steelhead	0.880378181	0.629004993	0.553762271	126.3	131.73	137.34	0.01996615	11046.39209	11.90219	12.69331469	8.103576326	10.79465351	94.54316254	0.986383641	1.073181725	6.416526198	27.9009632	12.82372395	291.3820496	0.90657109	17.41735427	307.3956909	0.657552956	0.431030416
1955	Steelhead	0.91275721	0.589288506	0.537874321	128.61	132.6	139.21	0.019751672	10615.27206	11.28663138	8.653966658	11.12947399	11.0517458	81.17820892	0.993672144	1.005566788	6.876228049	25.51349171	13.42983278	233.7086258	0.939941516	16.74063857	248.094696	0.658111514	0.388321069
1956	Steelhead	0.922771981	0.643611762	0.593906901	132.71	136.21	141.06	0.019292907	11447.43232	14.12822396	7.767821379	12.19402662	11.28767624	141.734967	0.978933573	1.31863842	5.258324586	34.59121006	13.34108988	408.3592682	0.86525628	20.45940129	426.9901428	0.703703561	0.472130233
1957	Steelhead	0.901575991	0.637239752	0.574520061	130.4	134.94	137.97	0.018786796	10784.3399	13.74947415	10.23492891	9.872158817	11.38114834	136.4914032	0.977861249	1.199919987	5.412052155	33.8038193	13.19495217	397.4228668	0.864144911	19.68926938	415.3557739	0.678721816	0.456148518
1958	Steelhead	0.926251822	0.611752677	0.566637032	132.09	135.35	139.85	0.019029622	10772.53603	12.894007	7.367227897	12.69417062	11.64530163	127.6874191	0.981419861	1.178004074	5.629998669	32.22129125	13.70618296	355.6419169	0.87670509	18.64684995	372.5683899	0.686162752	0.434291714
1959	Steelhead	0.880755175	0.578445761	0.509469098	127.1	132.54	138.06	0.019466051	9907.026111	11.96837412	12.7262331	7.822013813	11.6015028	78.98971405	0.988623285	1.168867874	6.199783549	28.67592838	14.03494851	289.0211945	0.909507513	17.72262224	299.4566956	0.618596915	0.388662735
1960	Steelhead	0.898656712	0.605890001	0.544487116	126.52	131.26	136.85	0.020714639	11268.44663	11.65533372	10.26003181	9.65014023	10.90004253	78.57050171	0.992915821	1.10636673	6.567001767	27.03232724	13.24464099	263.2879206	0.92404906	17.27898614	277.8250427	0.671548311	0.391728618
1961	Steelhead	0.904263435	0.582660266	0.526878373	129.28	134.34	141.57	0.019216429	10115.2822	12.31022702	9.675436512	11.56381054	72.4572998	0.988783157	1.134455585	6.120086849	29.18747646	13.96619908	302.8013407	0.907509824	18.01183097	314.9577026	0.645598986	0.391194878	
1962	Steelhead	0.932130121	0.574304312	0.535326348	131.5	134.75	140.67	0.019657926	10513.94126	11.69269535	6.54360719	13.75461315	11.48308735	88.26972198	0.994952333	1.176874924	6.346613623	27.71815196	14.07480494	260.0873871	0.926965793	17.45015367	265.8014526	0.696613673	0.375942668
1963	Steelhead	0.931590915	0.557095463	0.518985072	135.51	138.9	145.14	0.018250867	9461.858462	11.40242406	6.679887362	13.64576556	12.07456779	93.83895874	0.990484047	1.01924324	6.341201194	27.6719407	14.32001368	260.0899455	0.92065087	16.85448027	271.5150146	0.680833184	0.368770204
1964	Steelhead	0.927445598	0.576357427	0.534540159	134.81	138.22	143.57	0.018490918	9874.882474	11.84383968	7.138092063	12.92101967	11.68520718	99.52077789	0.988610947	1.06229353	6.302202985	28.05573996	14.16505003	283.6048228	0.91143625	17.34620269	298.5183105	0.679760061	0.397650974
1965	Steelhead	0.91313158	0.604098809	0.551624249	135.43	138.99	144.69	0.017633401	9717.695436	12.34980444	9.024948016	10.72518078	11.54698887	131.7182327	0.981067681	1.14915781	5.694014601	31.34509682	13.82818826	329.9228923	0.884787808	18.05310901	336.6486816	0.661681497	0.413070407
1966	Steelhead	0.930952496	0.537037319	0.499956232	132.1	135.47	140.77	0.019871125																	

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Appendix E: Fish, Aquatic Macroinvertebrates, and Aquatic Habitat

Year	Species	InRivSurvSNK	InRivSurvLCol	InRivSurv	MedDayLGR	MedDayConfl	MedDayBON	SAR	TotalReturn	meanGas	SNKTravelTime	SNKMigRate	SNKTemp	SNKFlow	SNKFSpill	SNKGas	LCTravelTime	LCMigRate	LCTemp	LCFlow	LCFSpill	LCGas	BonFlow	monte_q975	monte_q025
1986	Steelhead	0.904048104	0.559345052	0.505674834	132.56	136.85	142.97	0.018456246	9322.652388	11.82232577	9.987126932	9.744572859	11.69566956	108.5246719	0.989734924	1.111314201	6.283696316	27.96229923	14.30096245	272.3168411	0.918467611	17.46716468	277.5614624	0.619127012	0.376890179
1987	Steelhead	0.905665684	0.42323813	0.383312251	134.63	138.82	138.48	0.019227819	7362.299962	11.21562995	9.731433555	9.603790884	14.43050327	52.35490494	0.989934695	1.114935207	6.396369249	26.78175613	16.11029132	230.9827652	0.933398892	16.70613988	235.5072174	0.576453786	0.240237558
1988	Steelhead	0.92122308	0.55656433	0.512719906	134.09	137.75	143.44	0.018414763	9431.133945	10.76107294	7.715888873	11.8111583	11.57831993	62.73820343	0.994098532	0.98125124	7.102435336	24.1400813	13.75205437	192.7078985	0.956274807	16.06876516	198.7187805	0.650759849	0.370433209
1989	Steelhead	0.896064445	0.613016781	0.549302542	123.3	128.46	133.59	0.022009491	12078.66196	11.8602531	10.47670518	9.560909763	10.86094227	93.96195068	0.993406832	1.158818531	6.364226773	28.19843768	13.12369394	282.5874074	0.913659285	17.62292353	289.0899353	0.683585792	0.405460239
1990	Steelhead	0.922560821	0.416372413	0.384128875	141.15	144.89	147.14	0.017223228	6610.41062	11.50735893	7.774322502	11.78817988	14.94555817	70.34169464	0.986305881	1.127603626	6.044709906	28.38622095	16.87754345	259.2722321	0.918871224	17.08730523	262.5505981	0.639432225	0.228128483
1991	Steelhead	0.886147128	0.551216991	0.488459354	132.39	138.44	142.81	0.017537789	8557.147549	11.54785449	12.02621078	8.282938661	12.13352776	68.43561554	0.98329879	1.082971573	6.234157905	28.26663801	14.5012668	273.9857585	0.908764899	17.07459625	273.2573242	0.608642299	0.366945181
1992	Steelhead	0.915756278	0.426835355	0.390877156	134.52	138.46	141.22	0.019157729	7481.089617	10.87409033	8.375935495	10.89748675	14.26045799	50.10090332	0.992548215	1.037850189	6.764475204	25.12735493	16.01404444	198.1802444	0.952689976	16.30038802	199.5639343	0.579843449	0.239852514
1993	Steelhead	0.907400378	0.619245816	0.561903887	130.08	134.27	139.03	0.020024105	11241.42007	11.77443286	9.358392142	10.64266233	10.96669292	107.5979172	0.983264768	0.986349678	6.423411027	27.94141803	12.84444555	288.6217143	0.90532585	17.1998407	299.6308899	0.685791019	0.425070912
1994	Steelhead	0.905060624	0.447215681	0.404757304	133.05	137.17	139.51	0.019360976	7828.204952	10.8266465	9.793310784	9.66681766	12.95371265	59.55548096	0.991505349	1.059957218	6.900047347	24.662653	15.35882616	196.690094	0.950432857	16.14534998	202.4002075	0.573324729	0.276330936
1995	Steelhead	0.903884782	0.572429413	0.517410235	128.25	132.55	139.26	0.019584422	10124.75335	11.4703738	9.752284072	10.24077629	11.48763981	93.94382324	0.99206053	1.050737095	6.478395797	27.28253302	13.97645966	259.7134043	0.924408515	16.98139906	272.2706299	0.646283143	0.389437935
1996	Steelhead	0.907474213	0.580971247	0.527216425	134.84	138.47	143.07	0.01771414	9329.510598	12.48205873	9.680202328	10.10519379	12.60196209	125.1081558	0.977878773	1.139690208	5.592656553	31.66971637	14.35034704	335.6924388	0.884078165	18.15841166	346.5257874	0.65441472	0.398232698
1997	Steelhead	0.934927135	0.623786958	0.583195353	138.48	141.07	144.81	0.017819135	10382.85147	15.89503983	6.52722194	14.14145924	11.97265377	169.6637024	0.971486628	1.502549744	4.563989899	39.92341745	14.45801306	484.1472931	0.840475887	23.20323149	489.4086304	0.705678593	0.436261873
1998	Steelhead	0.936698059	0.591519784	0.554075433	132.11	134.97	140.48	0.019869755	10998.49087	12.4581118	6.103095636	14.98278967	11.96026249	131.4403137	0.976730919	1.134665012	5.532217167	32.38630938	14.26392301	344.7746429	0.875751088	18.11008358	352.1695557	0.683044853	0.396112211
1999	Steelhead	0.925906172	0.573600697	0.531100426	137.33	141.03	146.65	0.017590061	9333.921849	12.29988173	7.407806218	12.55343148	12.19056129	110.8438919	0.98545593	1.131844139	5.823649652	30.35254546	14.40454594	311.6775106	0.899670025	17.95027733	323.964447	0.666240008	0.390945323
2000	Steelhead	0.914877999	0.481237056	0.440273195	134.84	138.88	141.72	0.018694118	8220.956141	11.5890099	8.745212197	10.77738576	13.04804955	85.66663361	0.991971397	1.211767769	6.269889683	27.46012235	15.29232232	245.7944616	0.932058513	17.33489068	254.5999146	0.591896072	0.296855457
2001	Steelhead	0.915933641	0.497625075	0.455791547	134.29	138.02	144.02	0.017889299	8146.152328	10.17166407	8.335078597	11.18723868	12.02075272	59.74881668	0.989842343	0.908218861	7.316596247	23.02713942	14.63610284	169.2177022	0.954553584	15.0739948	177.3386841	0.611718072	0.326029567
2002	Steelhead	0.902224447	0.579670681	0.522993059	129.4	134.32	140.01	0.019556006	10217.58334	11.7690708	9.951279931	9.785462228	11.30199795	76.16759949	0.991121149	1.147953701	6.453806035	27.08290655	13.84608332	262.6516164	0.925335844	17.47450082	272.9683228	0.645881562	0.389939179
2003	Steelhead	0.914639262	0.567545313	0.519099226	130.29	134.52	141.77	0.019194182	9953.836422	11.69417586	8.492436647	11.15811237	11.63504429	81.82277832	0.99148823	1.083253479	6.515399456	26.70989856	13.96659485	254.9020386	0.930055837	17.21970336	274.6119995	0.645722541	0.383731139
2004	Steelhead	0.927357323	0.541102519	0.501795384	133.4	137.15	143.66	0.018259661	9153.897941	11.3791666	7.053150982	13.02060213	11.96562195	79.27626953	0.996190333	1.108075333	6.556841038	26.19982477	14.50953738	229.363416	0.943596035	16.96340688	249.3887634	0.644791211	0.348721781
2005	Steelhead	0.926950674	0.503890982	0.467082086	134.39	137.72	141.92	0.018382735	8578.950127	11.21445077	7.136997737	12.96161554	13.37923183	84.75066223	0.994252837	1.051383972	6.445758343	26.60841124	15.27640343	230.1927694	0.939822396	16.74060996	236.7787933	0.619948173	0.305757366
2006	Steelhead	0.895485537	0.631268899	0.565292169	129.23	133.53	138.47	0.02029532	11461.00094	12.84420708	11.03633439	9.2211195556	11.02763309	136.787146	0.982354367	1.197616386	5.762199946	31.20979944	13.09519609	346.2032267	0.885413875	18.70550712	357.2106628	0.674874319	0.442355804
2007	Steelhead	0.89992833	0.528234281	0.475372994	126.62	132.15	136.2	0.019507337	9264.298732	11.52442384	10.11478405	9.830265026	12.7965107	68.11459885	0.994151473	1.14369154	6.3553138	27.17870241	14.85756906	247.5346909	0.933105499	17.23771922	254.7496796	0.622188652	0.316571399
2008	Steelhead	0.917796035	0.578542226	0.530983761	134.79	138.7	143.03	0.018117978	9611.822089	12.28164148	8.233011588	11.76331624	12.02190857	112.1785431	0.981550181	1.060881424	6.124804817	28.84980148	14.21084007	311.6900991	0.8976671	17.7098333	328.5264282	0.649373051	0.398263109
SCN MO3-RESSIM-SAL																									
1929	Steelhead	0.896404826	0.57219035	0.512914191	128.47	130.27	137.12	0.020370096	10438.26138	9.81203304	4.393150523	19.64609822	11.05545006	63.82778244	0.982632887	0.793209839	8.328929938	20.77013038	12.70908244	165.2178116	0.946995318	14.46935479	176.1290894	0.635994963	0.395027466
1930	Steelhead	0.754506966	0.446434311	0.336837797	140.16	140.21	143.9	0.01857351	6250.748091	9.894645521	3.86003042	22.08241311	13.21075382	62.70593262	0.985576141	0.905415058	7.678334981	22.01112095	15.08399041	159.0707677	0.951663693	14.5319651	164.8411407	0.502351442	0.240046535
1931	Steelhead	0.819409272	0.458975423	0.376088718	138.02	139.24	144.36	0.018814931	7069.412837	10.09336659	3.587064728	23.73527577	12.62741623	58.86043243	0.990219724	0.958304501	7.43275062	22.60556987	15.13726981	161.9846242	0.957180421	14.92655834	167.0583496	0.536485475	0.250273738
1932	Steelhead	0.91996341	0.649212346	0.597251603	121.13	123.49	129.16	0.022118218	13199.0931	11.94124079	4.242455661	20.46083254	10.53812847	99.57953033	0.988763583	1.09147625	6.5642519	27.65612496	12.20318778	292.7756602	0.910047382	17.64748637	304.4317932	0.717040501	0.464734673
1933	Steelhead	0.891480232	0.585149624	0.521649323	127.65	129.55	135.13	0.020345437	10602.48455	11.464896	4.456168808	19.43170886	11.33985081	68.18749084	0.989073682	1.023069382	7.004742913	25.46742892	13.36325423	247.8490067	0.931248983	16.95366081	263.3229675	0.638590025	0.41803955
1934	Steelhead	0.708992631	0.487274981	0.345474371	138.63	138.2	139.61	0.01938923	6691.829648	11.80909978	3.76440233	22.63763276	14.37220631	59.37915726	0.986854625	1.198201275	5.974547252	29.33341021	15.45164076	285.1780446	0.905493965	17.56161229	290.4157715	0.502606531	0.252600751
1935	Steelhead	0.892439992	0.568780313	0.507602298	125.94	127.93	134.38	0.021162373	10731.75636	11.1316123	4.002016	21.47374829	11.40548744	67.98436737	0.993132329	1.019650269	7.16366668	24.52938334	13.51748625	221.4864477	0.944690824	16.59884659	232.6940002	0.632765953	0.379483616
1936	Steelhead	0.850459035	0.65519331	0.523473976	122.36	122.51	126.33	0.021291917	11134.72124	11.1363551	4.524609543	19.16133342	11.11823978	115.172731	0.982979222	1.08417511	6.847507112	26.							

Columbia River System Operations Environmental Impact Statement
Appendix E: Fish, Aquatic Macroinvertebrates, and Aquatic Habitat

Year	Species	InRivSurvSNK	InRivSurvLCol	InRivSurv	MedDayLGR	MedDayConfl	MedDayBON	SAR	TotalReturn	meanGas	SNKTravelTime	SNKMigRate	SNKTemp	SNKFlow	SNKFSpill	SNKGas	LCTravelTime	LCMigRate	LCTemp	LCFlow	LCFSpill	LCGas	BonFlow	monte_q975	monte_q025
1956	Steelhead	0.923707759	0.665863282	0.615063081	129.3	130.96	135.47	0.020385955	12526.61927	13.95670332	3.705699094	23.23676113	10.84546814	140.7667145	0.975665498	1.260844994	5.468505844	33.69276815	12.50887648	406.4331207	0.861614853	20.13580306	425.0817261	0.718689536	0.482012951
1957	Steelhead	0.912058643	0.655641868	0.597983833	123.68	125.44	130.57	0.019927961	11906.70036	12.8775786	4.441955186	19.57622505	10.6985424	129.0360443	0.974527824	1.077175713	6.391599946	28.72532428	12.24531603	343.9087067	0.885906845	18.62470357	359.8193359	0.692491335	0.464518845
1958	Steelhead	0.914431104	0.634604223	0.58030184	128.65	130.25	135.07	0.020257347	11744.08313	12.49406518	3.725073703	23.05621371	11.13103008	121.8859909	0.980503166	1.110761166	6.24333062	29.38095123	12.81690645	329.7268728	0.887094229	18.15130695	346.9906006	0.683843497	0.465045155
1959	Steelhead	0.89208689	0.613460243	0.54725984	119.53	121.69	126.24	0.02072507	11330.2162	11.40239075	5.627502717	15.54205756	10.72065678	74.9362381	0.975803876	1.015288353	7.13815093	25.50587703	12.56462987	263.1998316	0.909591645	16.87416252	274.5951538	0.665244553	0.439899415
1960	Steelhead	0.922308219	0.638167018	0.588586686	120.6	122.97	129.39	0.022111045	13001.97795	11.4711878	4.520997494	19.15787331	10.28928757	78.78773651	0.992888153	1.079260635	7.179466464	24.88390571	12.01974773	244.9225006	0.934343924	17.10478131	255.4190216	0.716399578	0.431868076
1961	Steelhead	0.902179407	0.60371928	0.544663102	123.79	125.95	132.53	0.020702897	11265.4485	11.77524076	4.385648131	19.70446374	11.00650787	69.32971191	0.987746227	1.029169464	6.825082563	26.32627311	13.10548846	271.1297379	0.920370559	17.31652832	282.6332703	0.662015289	0.421937837
1962	Steelhead	0.914574859	0.59429912	0.543531033	129.55	131.39	136.98	0.020878863	11337.6012	11.62428505	3.489296585	24.46415093	11.24126205	88.10972443	0.994562316	1.155988216	6.594088994	26.88694682	13.44529915	255.4711482	0.929607123	17.3652571	261.3048706	0.682464363	0.396034598
1963	Steelhead	0.892552256	0.565790702	0.504997768	133.49	135.4	142.46	0.019521707	9847.860954	11.19440246	3.54872144	24.1229229	11.79104404	88.84111328	0.989487457	0.971642017	6.773732163	26.08661714	13.88234043	244.9379476	0.926648239	16.53789616	257.5479431	0.638980145	0.367248218
1964	Steelhead	0.910044643	0.590657588	0.537524774	131.58	133.47	139.4	0.020085386	10786.03637	11.30993891	3.701803245	23.1592305	11.25650406	93.43356323	0.98772887	1.001938248	6.942563869	25.48777044	13.37106673	251.6714223	0.922464301	16.61736727	263.9472656	0.663831449	0.412042734
1965	Steelhead	0.913610686	0.630493035	0.576025174	131.74	133.53	138.43	0.018960945	10911.50625	12.11523747	4.191693738	20.67736427	11.00301476	126.7678345	0.97758975	1.075537586	6.155276738	29.63252103	12.82973512	322.467687	0.882045647	17.689768	332.0551147	0.680446272	0.462168687
1966	Steelhead	0.882724024	0.57459971	0.507212968	130.04	131.7	137.16	0.021209336	10745.9371	11.1269502	3.621065386	23.54895478	11.65660858	68.36349335	0.994591486	1.049771309	7.033034168	24.80028466	13.42401044	219.2739003	0.94637388	16.63656537	226.5662384	0.658326665	0.361696335
1967	Steelhead	0.891776763	0.619869732	0.552785423	133.7	135.23	140.8	0.018989459	10486.68061	11.65166044	4.346973307	19.85887816	11.26246243	88.02864838	0.977092147	1.000310135	6.910654821	25.83280788	12.71362289	280.2549947	0.902856876	16.9868083	289.3380432	0.665178631	0.438761601
1968	Steelhead	0.833762784	0.538012412	0.448574726	120.06	121.04	126.31	0.019372285	8680.331971	9.453710624	6.023260608	14.49283743	11.95480881	60.48068314	0.949843776	0.730220032	6.685131043	20.06627703	13.15001059	180.5535177	0.904026449	13.75874488	188.7473755	0.567501239	0.348369581
1969	Steelhead	0.911440591	0.608828437	0.55491095	133.28	134.98	140.07	0.020155677	11174.558	13.06876223	3.040269211	28.01316254	11.6565588	130.6308746	0.976312828	1.213567162	5.435539432	33.39408176	13.97409185	371.5631866	0.866227289	18.85858011	378.5861206	0.693738183	0.420336623
1970	Steelhead	0.916631182	0.615224101	0.563933595	124.14	126.61	134.23	0.020185853	11373.29909	10.58624056	4.484038122	19.35404671	10.59582996	84.63358154	0.981658483	0.838075256	7.778035529	22.75969266	12.27600447	223.7584712	0.923213452	15.51108917	233.4108124	0.67916912	0.43482883
1971	Steelhead	0.89302811	0.631374077	0.563834799	139.89	141.17	145.18	0.01805293	10169.42527	13.61407546	3.31407994	25.79185861	11.97907238	146.3385956	0.970946169	1.223018837	5.224903345	34.96538724	13.57395347	406.21993	0.84994333	19.54330603	412.9869995	0.671413056	0.430797126
1972	Steelhead	0.902140297	0.637185459	0.574830679	128.84	130.39	135.19	0.01979283	11366.06383	13.57007538	4.229539245	20.46731952	11.2472826	124.4462631	0.980565143	1.229454613	5.651298977	32.33838828	13.12061024	383.3737233	0.872650981	19.86900043	385.5175781	0.679108414	0.469003459
1973	Steelhead	0.884094208	0.550659624	0.486834984	117.72	120.58	129.09	0.019771673	9616.92096	9.49808274	5.420190036	16.08074657	10.77659855	50.5571907	0.970337832	0.782455254	8.780433103	19.67366429	12.92595021	155.2285716	0.934637219	14.05164997	161.3557739	0.606970037	0.369026977
1974	Steelhead	0.899441774	0.625077685	0.562220982	134.42	135.93	140.43	0.019284658	10831.82166	13.23502118	3.663339466	23.43826014	11.63127136	126.604895	0.97342732	1.203693771	5.41818957	33.46835929	13.51336686	380.5458934	0.86195448	19.20689106	386.7110291	0.675611635	0.434314725
1975	Steelhead	0.923859465	0.648018005	0.598677567	116.08	118.91	125.67	0.022015318	13168.68026	11.16915842	5.084749795	17.24105092	9.985357107	83.58813782	0.9897874	0.907075596	7.656961821	23.68241752	11.55098232	235.9888535	0.937657426	16.5305961	247.2622681	0.719684797	0.457385912
1976	Steelhead	0.927083727	0.668911762	0.620137209	124.16	125.96	131.04	0.02090303	12948.64875	12.30253278	4.339301363	20.02067125	10.3811409	131.3689972	0.975753379	1.117785358	6.230949216	29.3560437	11.90744702	328.9560852	0.882868926	17.99498018	333.1289978	0.724328737	0.498617897
1977	Steelhead	0.854830545	0.507916062	0.434182164	121.4	123.31	130.15	0.021808296	9460.135521	9.171996815	5.134325884	16.92021407	11.73026485	36.76270905	0.971774149	0.759212065	8.925983585	19.11760693	13.56092087	134.0347252	0.943731358	13.44835385	141.4520569	0.562492852	0.315867929
1978	Steelhead	0.896432857	0.604916457	0.542266987	135.22	136.82	141.78	0.019270309	10440.12626	11.70229449	3.572484337	23.95701216	11.62664471	94.80915222	0.992163098	1.138587379	6.384977207	27.45971185	13.284434	264.6935883	0.924999595	17.45861832	273.6483154	0.66325162	0.40498694
1979	Steelhead	0.914074822	0.628674519	0.574655549	122.38	124.56	130.71	0.021668461	12439.95452	10.9957742	4.639955707	18.70907814	10.59845524	79.38390961	0.984645069	0.919882011	7.518155225	24.01438388	12.09575748	232.9874395	0.930137356	16.23743725	247.1830444	0.711156709	0.449857714
1980	Steelhead	0.915560722	0.64622455	0.591657815	117.37	119.98	124.99	0.020641876	12201.98635	11.57835443	5.150686406	17.09334119	10.20369568	87.52772064	0.976709783	0.924421883	7.029357277	26.49639245	12.01251539	287.3805974	0.902963152	16.91244427	306.3229675	0.69153917	0.462253495
1981	Steelhead	0.813910324	0.526165034	0.428251153	138.32	139.03	143.97	0.017565093	7515.535563	11.34899364	3.643664837	23.52584149	13.57654171	89.95480957	0.97933166	0.988533783	6.491647698	26.99447945	14.90098111	264.7968216	0.91081051	16.69239219	273.5896606	0.552763216	0.308463138
1982	Steelhead	0.89943063	0.616141411	0.554176457	128.49	130.06	135.33	0.020027471	11086.85628	12.20161833	4.399626836	19.67876374	11.18741302	110.3999908	0.97991153	1.117410278	6.333283961	28.78731367	13.02074289	314.4502411	0.890233765	17.85340754	322.8909607	0.661396827	0.438200375
1983	Steelhead	0.909481507	0.620331505	0.564180032	127.95	129.68	134.55	0.01936454	10915.12463	11.83005479	4.556219198	19.11260473	10.90520668	102.5412827	0.982633114	1.036968708	6.596256636	27.50247394	12.86991788	290.219752	0.904457996	17.31657489	301.9002991	0.662619152	0.444448087
1984	Steelhead	0.917008205	0.626049254	0.574092302	126.31	128.16	133.36	0.020902387	11986.85803	11.50791904	4.227654658	20.47733254	10.76446934	123.5200653	0.985661614	1.0472774971	6.830230214	26.49914548	12.43791199	266.8156153	0.914784978	17.07453903	275.0581055	0.688786915	0.45148162
1985	Steelhead	0.922143076	0.634497566	0.585097537	122.99	124.9	131.05	0.022142346	12942.53651	11.33645817	4.212798946	20.49175795	10.4731781	95.66685638	0.993110919	1.034306049	7.230438568	24.6442372	12.02175824	235.3912811	0.939843973	16.97562011	242.7809753	0.709160187	0.461108762
1986	Steelhead	0.902688245	0.594979116	0.537080654	128.25	129.89	134.55	0.019566616	10497.43454	11.57930143	4.393635534	19.71052003	11.12368107	106.907579	0.988083303	1.054391479	6.722778492	26.497897	13.2116313	263.4075368	0.918498337	17.1319046	268.0259705	0.645456471	0.431588746
1987	Steelhead	0.746476783	0.506059933	0.377761991	129.38	128.85	131.3	0.0210653																	

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Appendix E: Fish, Aquatic Macroinvertebrates, and Aquatic Habitat

Year	Species	InRivSurvSNK	InRivSurvLCol	InRivSurv	MedDayLGR	MedDayConfl	MedDayBON	SAR	TotalReturn	meanGas	SNKTravelTime	SNKMigRate	SNKTemp	SNKFlow	SNKFSpill	SNKGas	LCTravelTime	LCMigRate	LCTemp	LCFlow	LCFSpill	LCGas	BonFlow	monte_q975	monte_q025
2007	Steelhead	0.856724783	0.565605943	0.484568629	119.84	121.62	126.88	0.021084432	10206.89314	11.38517424	4.516054206	19.25804403	11.9668602	62.26437759	0.993400764	1.07820425	6.971380718	25.22022076	13.69916789	236.2321192	0.940188219	17.0453976	244.1781616	0.600561271	0.363532554
2008	Steelhead	0.893723276	0.598397532	0.534801802	130.37	131.68	137.64	0.019793206	10575.94719	11.6931432	3.928961128	21.99711958	11.46669712	104.263472	0.980663323	0.972412586	6.90284624	25.67813058	13.25769726	279.2753042	0.908605347	16.87077363	294.5507202	0.641787377	0.427433185
SCN MO3-RESSIM-SNK																									
1929	Steelhead	0.944407521	0.578017024	0.545883624	127.92	128.76	135.55	0.020535357	11199.33597	9.677137681	2.055807069	41.28143458	10.92869759	62.42379227	0.977927637	0.766868496	8.623500131	20.19861589	12.41083988	161.9134979	0.943303446	14.23600451	173.075592	0.693197174	0.411221852
1930	Steelhead	0.821700286	0.461956696	0.379589949	138.85	138.42	142.66	0.018773126	7119.820834	9.758234365	1.919481657	44.14930445	12.87877502	62.21346817	0.981247473	0.879280853	7.982344516	21.39574361	14.67419926	157.5306854	0.944959293	14.29807806	163.3903198	0.510195519	0.272653702
1931	Steelhead	0.881013927	0.477384655	0.42058253	136.63	137.19	142.7	0.019373717	8140.556916	10.05936595	1.969978489	43.06802783	12.36698494	58.84364548	0.988747418	0.936647224	7.603114791	22.24354929	14.75657352	162.7002538	0.955072979	14.87135379	167.9967499	0.5736282	0.289367307
1932	Steelhead	0.966533656	0.657668892	0.635659118	119.3	120.31	126.06	0.022024199	13988.26231	11.80969858	1.737669356	48.92129708	10.26670856	98.57740021	0.981174004	1.030682373	6.793946154	27.018795	11.8026673	288.9082438	0.908701797	17.43848435	301.9046021	0.750556001	0.469612858
1933	Steelhead	0.94659711	0.590514111	0.558978951	126.1	126.98	131.99	0.020520471	11458.95694	11.17244104	2.022724532	42.00650616	11.12950554	65.22486343	0.981199062	0.972707272	7.434524968	24.16743102	12.9463013	235.6095606	0.928727686	16.47657998	250.6846008	0.684491736	0.427202396
1934	Steelhead	0.767172725	0.497529193	0.381690827	138.24	137.23	138.81	0.019317961	7366.186801	11.70987201	1.8942426	44.8192908	14.22887383	59.7496994	0.98449738	1.179457378	6.093769982	28.94061587	15.17217573	285.2144623	0.899663299	17.37480974	290.5718384	0.5239388	0.274215635
1935	Steelhead	0.944188301	0.579471335	0.547130055	124.39	125.41	131.63	0.021525349	11765.8483	11.00830487	1.936995253	43.84849949	11.16278019	67.30825806	0.989745474	0.982171059	7.462159127	23.73535812	13.06860876	216.1095403	0.944284747	16.39626487	227.2841187	0.676649595	0.408085187
1936	Steelhead	0.903505467	0.619910938	0.560092922	120.72	119.71	123.55	0.020888541	11687.82551	11.3503902	1.723034956	49.34239114	10.85079174	110.1766068	0.968249393	1.003802204	7.411155485	25.39064318	11.9977808	277.4890671	0.8898727	16.66187223	292.4010925	0.652473477	0.442490162
1937	Steelhead	0.96229482	0.589378441	0.567155821	117.86	119.2	127.46	0.022191437	12574.32377	9.465528318	2.243339218	37.89022461	10.22553787	48.80555038	0.968232882	0.697959328	9.403710566	19.08277667	11.83895143	157.0655848	0.929955631	13.80268248	170.1932526	0.703449776	0.410650413
1938	Steelhead	0.96237532	0.638254544	0.614240421	121.62	122.28	126.18	0.021127506	12964.92154	11.9015412	1.670599088	50.90113167	10.72307091	109.0496124	0.974249625	1.024262714	6.555801547	28.00008178	12.27295939	304.5385946	0.894396077	17.35947482	319.382843	0.734551768	0.489600261
1939	Steelhead	0.848467743	0.551578014	0.467996152	136.33	136.04	139.76	0.019706661	9214.238943	11.04715633	1.814730242	46.77268937	12.14235706	77.3489212	0.986960304	1.098605156	7.200677797	24.39639516	13.29609664	216.9308879	0.935671479	16.49588585	222.745163	0.580591157	0.3586832
1940	Steelhead	0.882583046	0.56264404	0.49658009	126.54	125.66	128.5	0.020567499	10201.67242	10.95990559	1.780642189	47.68881812	11.57603931	83.48213806	0.981424654	1.005593014	7.481772631	23.88932363	13.17182859	222.6467336	0.927517543	16.32078123	230.4407959	0.607438883	0.38477695
1941	Steelhead	0.900708592	0.51277171	0.461857885	127.85	128.31	133.37	0.020400553	9414.017861	10.21933178	2.051184095	41.40782622	12.91723213	54.05540543	0.98906821	0.838633347	7.798830628	22.08829192	14.17749008	177.2918523	0.953024815	15.17223159	184.7454071	0.610899315	0.330660283
1942	Steelhead	0.964663201	0.631653709	0.609333089	118.49	119.15	124.78	0.020743259	12627.23456	10.71428067	1.860756606	45.66254264	10.16017609	80.64489746	0.974910128	0.859461975	8.010463096	22.60298249	11.59986766	212.1547343	0.935747176	15.84205929	223.0956879	0.721656569	0.450989927
1943	Steelhead	0.963880921	0.626858972	0.604217404	125.91	126.78	131.49	0.021439083	12941.8605	11.78985531	1.632063851	52.04033296	10.77762203	116.0526001	0.983289921	1.085265827	6.481952451	27.6632999	12.55505006	288.2841899	0.904228916	17.35842514	298.2898865	0.734186711	0.457284076
1944	Steelhead	0.954717341	0.559176481	0.533855483	119.59	120.55	127.78	0.021906868	11684.77986	9.159626518	2.182073653	38.86941248	10.36599998	50.50281601	0.971699202	0.721602726	9.335228994	18.6371543	12.31190507	138.8908234	0.943197985	13.46718327	146.7219543	0.675470963	0.398721603
1945	Steelhead	0.945288535	0.582573231	0.550699797	128.69	129.32	134.38	0.020876377	11484.89561	10.72410182	1.889786869	44.97173626	11.26701946	80.34062805	0.98669548	0.913335228	7.620852932	23.22050381	13.04504013	213.0422897	0.937636008	15.87103192	226.9079895	0.700398734	0.416059082
1946	Steelhead	0.967504904	0.667670349	0.645974337	121.77	122.53	126.82	0.022014582	14208.32284	12.11323745	1.658422314	51.24838168	10.24416332	109.4587265	0.973102129	1.025263214	6.449030392	28.83932536	11.60024389	324.6413371	0.884797176	17.67604812	339.0128174	0.760545555	0.489235722
1947	Steelhead	0.860517128	0.552695237	0.475603718	133.26	132.47	135.21	0.019916247	9462.398387	11.70011544	1.618363157	52.50736431	12.52007866	111.9126175	0.972857785	1.111180401	6.360966444	28.35971743	14.16969554	299.7569784	0.881533931	17.20551777	308.4036865	0.597843055	0.350778183
1948	Steelhead	0.950052388	0.635548615	0.60380448	132.61	133.37	138.63	0.019760905	11920.85271	14.53126206	1.559862696	54.55858579	11.58298359	140.9909027	0.979750681	1.317539406	5.662003867	32.54953113	13.43436797	408.495341	0.870076219	21.54741796	429.1503296	0.730559905	0.453130325
1949	Steelhead	0.963052924	0.647948184	0.624008393	120.13	120.7	124.8	0.021741534	13552.49305	12.22815061	1.610098407	52.83108207	10.46311512	122.4954971	0.978264964	1.06553545	6.4868076	28.55958544	12.04618041	323.002065	0.886618823	17.79162137	340.5340576	0.730663898	0.493250438
1950	Steelhead	0.960866987	0.645192818	0.619944479	122.87	123.74	130.08	0.021147585	13095.86159	11.27143727	1.768322408	48.0090431	10.42506371	91.33742371	0.98101052	0.997033024	7.31827905	24.7536792	11.61870686	251.933342	0.915474405	16.65654977	266.1247864	0.742174896	0.462968044
1951	Steelhead	0.957546	0.626157863	0.599574958	122.03	122.86	127.85	0.021487978	12869.66076	12.04405986	1.687210992	50.36665546	10.89800758	100.8697357	0.982089508	1.095694637	6.348158799	28.83628181	12.68831062	314.9921265	0.888429463	17.57722346	329.2552185	0.726225488	0.4682845
1952	Steelhead	0.96916989	0.671675414	0.650967587	123.44	124.11	128.86	0.021804429	14178.78154	12.46011591	1.471653342	57.83011603	10.4472887	155.7930542	0.96999557	1.058277893	6.060200334	30.67327156	11.81897465	352.258194	0.866459539	17.94711542	366.5858459	0.771236232	0.50749422
1953	Steelhead	0.961233135	0.60941238	0.585787373	125.51	126.3	132.44	0.020065488	11743.77128	11.23858932	1.873108193	45.39534502	10.80365467	82.50395203	0.98514694	0.923733997	7.277809143	24.79707517	12.7768542	247.2917862	0.925742557	16.5031023	265.0632629	0.714400935	0.446609315
1954	Steelhead	0.970655268	0.668042726	0.648439192	114.51	115.2	120.93	0.020849241	13506.90221	11.0985727	1.879582129	45.19236617	9.656412125	84.42534027	0.957962775	0.861542225	7.829491936	23.87127874	10.78434388	255.8834432	0.902608633	16.2073849	272.7609558	0.761802149	0.494546107
1955	Steelhead	0.96554114	0.608052835	0.587100027	122.95	124.01	130.84	0.021664944	12708.89459	10.57743096	1.915205367	44.34376084	10.46811771	73.23875427	0.987916338	0.872291279	8.046966806	22.08257	12.2636474	199.8270874	0.945882668	15.61128553	213.2886047	0.722059452	0.447075065
1956	Steelhead	0.965467469	0.670888677	0.647721192	127.81	128.64	133.24	0.020482374	13254.14568	13.67505642	1.551852532	54.83151105	10.67522488	73.585611	0.973331535	1.211978054	5.68771752	32.69349835	397.1357015	0.85936298	19.65728283	417.4082031	0.756843507	0.541160777	
1957	Steelhead	0.960931875	0.656856693	0.631194534	121.88	122.45	128.38	0.019688815	12417.09548	12.60520623	1.651598537	52.61827136	10.49365748	128.227446	0.960550463	1.00800457	7.35840358	27.44919691	11.94897827	332.213					

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Appendix E: Fish, Aquatic Macroinvertebrates, and Aquatic Habitat

Year	Species	InRivSurvSNK	InRivSurvLCol	InRivSurv	MedDayLGR	MedDayConfl	MedDayBON	SAR	TotalReturn	meanGas	SNKTravelTime	SNKMigRate	SNKTemp	SNKFlow	SNKFSpill	SNKGas	LCTravelTime	LCMigRate	LCTemp	LCFlow	LCFSpill	LCGas	BonFlow	monte_q975	monte_q025
1977	Steelhead	0.923275467	0.519244174	0.479405408	119.65	120.34	127.22	0.021914222	10496.23279	8.927125301	2.392723761	35.44330584	11.3860405	36.02304153	0.962040806	0.712500811	9.465697177	18.17019995	13.05276934	128.9196943	0.933557669	13.04303018	136.4020386	0.619157765	0.350381813
1978	Steelhead	0.943765594	0.609444624	0.575172868	134.78	135.62	140.58	0.019445619	11174.39892	11.63171881	1.703874521	49.87182442	11.54311409	94.61353912	0.99053067	1.122973347	6.495955624	27.09161496	13.10257896	263.0589854	0.922792931	17.33636888	271.9752502	0.70342463	0.437363788
1979	Steelhead	0.962127392	0.629312339	0.605478639	120.58	121.51	128.32	0.021661207	13102.81126	10.67064479	1.906010292	44.5370023	10.40276165	76.74631653	0.97412107	0.862904835	7.995775141	22.75420426	11.77653567	221.7910461	0.922290037	15.66671848	235.8960266	0.740470929	0.444273737
1980	Steelhead	0.965198067	0.648659579	0.626084972	114.7	115.29	121.59	0.020509609	12829.25216	11.05479578	1.942470141	43.71076688	9.906707382	81.56938477	0.958000255	0.831768417	7.934712388	23.74138117	11.37985086	261.4382655	0.901164313	16.05413938	280.9003601	0.731906847	0.464157407
1981	Steelhead	0.880719004	0.529268594	0.466136909	137.98	138.07	143.07	0.017675346	8231.748354	11.19799188	1.75436601	48.40467927	13.46868839	88.77433319	0.975557709	0.965102291	6.718850255	26.16315852	14.69026756	259.556516	0.907541682	16.43760204	268.3829346	0.598981489	0.348111744
1982	Steelhead	0.951692094	0.62373794	0.593606466	126.97	127.62	132.29	0.019827137	11756.90589	11.89145599	1.6542776	51.37652955	10.94748554	108.76707	0.975004411	1.075795364	6.635788329	27.70673527	12.54840024	305.6701508	0.882509937	17.35148319	314.3806152	0.719375716	0.458914146
1983	Steelhead	0.961122484	0.624092917	0.599829735	126.29	126.88	131.08	0.019262398	11543.62544	11.49791057	1.749238312	48.58794343	10.68498955	99.55403595	0.974321973	0.982891273	6.988309413	26.1350537	12.46339115	277.8696416	0.897498449	16.77179782	290.2330627	0.712220695	0.459773612
1984	Steelhead	0.963434597	0.634970416	0.611752467	124.73	125.59	130.59	0.020789309	12704.05952	11.26178006	1.611928694	52.71886071	10.52229958	121.1428986	0.977781332	0.99959259	7.138589516	25.65877799	11.96137985	261.9307073	0.903994739	16.63731575	270.7822876	0.735830094	0.480836069
1985	Steelhead	0.965217876	0.641486421	0.619174161	122.36	123.26	129.29	0.022013616	13616.7287	11.27416924	1.730986394	49.04827076	10.36995163	96.26601868	0.987771332	0.993084335	7.326652519	24.56984055	11.75861136	239.054095	0.934472541	16.82617601	247.821701	0.755439846	0.469681508
1986	Steelhead	0.954930274	0.604907366	0.577644357	126.69	127.3	131.32	0.019321995	11149.04485	11.3454565	1.667900518	50.92995488	10.91304684	106.0566391	0.984047556	1.012547207	6.924727567	25.9522592	12.76732747	261.2251536	0.908594002	16.70139917	265.8638	0.71233226	0.45878962
1987	Steelhead	0.814088643	0.517999905	0.42169784	127.96	126.72	129.4	0.020845558	8781.069556	10.64853839	2.032799661	41.67236941	12.95933743	53.74814529	0.970947134	0.979227829	7.686961524	23.31839996	13.87350384	222.7730357	0.90976884	15.70330318	229.0942535	0.54161676	0.326771885
1988	Steelhead	0.949123638	0.588547154	0.558604016	130.2	131.33	137.31	0.020389314	11376.87412	10.58042489	1.988356173	42.61176579	11.11414509	61.68101578	0.989496875	0.918593884	7.674675003	22.73789995	12.75811545	189.0765025	0.953096807	15.75203101	195.2707672	0.697162661	0.420368169
1989	Steelhead	0.972816589	0.6799928233	0.661445465	113.43	114.27	120.35	0.022597551	14932.93957	11.48165464	1.736478418	48.87498421	9.681834221	97.62979889	0.984986591	0.966850281	7.31601657	25.54891172	10.74417098	270.9819921	0.917677909	17.00156832	282.3641357	0.773913735	0.49826322
1990	Steelhead	0.812698475	0.482561286	0.392176821	136.61	135.76	137.48	0.019311032	7567.035835	11.02217245	1.862332456	45.53372873	13.82674789	66.51201019	0.979477668	1.040451813	6.963348128	25.27916253	14.92963568	235.0402807	0.916493634	16.33179998	241.2984009	0.533922766	0.281401324
1991	Steelhead	0.93947621	0.60486785	0.568258956	120.91	120.54	124.54	0.019239262	10920.98048	10.91002945	2.047503017	41.43791359	10.80307693	63.55664673	0.956734502	0.891715145	7.607952267	24.22258067	12.42140547	249.8678665	0.89401258	16.02296273	251.8464966	0.682396783	0.441234256
1992	Steelhead	0.845971548	0.504472411	0.426769307	129.12	129.14	133.42	0.021050771	8975.090585	10.42528554	2.050770506	41.36928948	13.1704525	50.35667267	0.978773212	0.919053268	7.752750389	22.63893857	14.20603418	193.2508799	0.935411255	15.50035365	196.1519623	0.564069824	0.315154004
1993	Steelhead	0.965305994	0.636746113	0.61465484	123.52	124.42	131.76	0.021447426	13170.61314	10.8706583	1.799720436	47.17075189	10.26640911	96.25097046	0.97806865	0.828869629	7.804560974	23.20569458	11.68006404	243.0054626	0.917404821	15.78692079	254.2701874	0.733740132	0.453289255
1994	Steelhead	0.878074557	0.543415883	0.477159661	126.68	126.46	130.33	0.020939346	9980.859032	10.43439225	2.024039857	41.90067971	11.48439083	59.42835617	0.976613057	0.937110329	8.210085824	21.75120104	13.10595163	190.9553706	0.934398293	15.48018662	197.2277985	0.617766876	0.364609178
1995	Steelhead	0.95957962	0.602775597	0.578411178	119.92	120.71	127.19	0.021206546	12255.8925	10.78511024	1.80952014	46.94051576	10.56839867	86.83223877	0.981830561	0.905512524	7.724846423	23.09801684	12.48196538	221.3573761	0.933475941	15.91495148	230.7607727	0.699885736	0.445857118
1996	Steelhead	0.935746296	0.623748349	0.583670207	127.95	128.28	130.44	0.019045444	11104.69479	11.91145359	1.620499134	52.44656604	11.57348881	118.2889282	0.96769129	1.02497654	6.340410128	28.85455108	12.50204404	321.8462524	0.870035281	17.26289876	335.1849365	0.6986559	0.472222982
1997	Steelhead	0.957793993	0.650343454	0.622895054	134.31	135.04	138.9	0.019287072	12003.05514	15.15501635	1.433926716	59.39017768	11.36882763	166.3526733	0.970166624	1.379742432	5.029007681	13.30293417	459.9169769	0.841392587	22.01428763	467.0167236	0.736504334	0.498026136	
1998	Steelhead	0.951880035	0.604796749	0.575693951	128.71	129.5	134.35	0.021403967	12309.5055	12.03706336	1.620850109	52.4850686	11.50982513	119.8513214	0.97843256	1.038471508	6.225543283	29.27078495	13.55119626	315.9241384	0.888792853	17.53958909	327.8252258	0.716871981	0.427984006
1999	Steelhead	0.943672651	0.598545309	0.564830838	133.58	134.57	140.69	0.019119568	10789.64221	11.97367447	1.693359554	50.2372584	11.62525749	103.892363	0.984822154	1.0723279	6.29392416	28.49592538	13.41983366	296.7595774	0.902330309	17.50766929	309.9812012	0.696680393	0.427320881
2000	Steelhead	0.87434887	0.565890951	0.494786114	129.88	129.51	132.69	0.020169424	9968.054542	11.30115461	1.754343174	48.47743341	11.84303131	87.15810547	0.97773031	1.103100777	6.947648011	25.82150561	13.23482275	254.9361064	0.909311523	16.76185767	264.9900208	0.614635966	0.390455089
2001	Steelhead	0.938428627	0.531082513	0.498383034	129.92	130.87	137.32	0.019846198	9881.663687	9.859524659	2.059752785	41.23555607	11.4028532	57.20214157	0.981994724	0.820332813	8.134386301	21.10760854	13.62295389	161.6595281	0.949301024	14.55026364	170.4470825	0.633903344	0.376110006
2002	Steelhead	0.95929431	0.629079124	0.603472024	122.97	123.83	128.33	0.02106842	12701.59204	11.41591116	1.891854785	44.91972394	10.50216637	76.55457001	0.981510866	1.019870472	7.219336852	24.96964233	12.03053077	251.7400335	0.922583252	16.9373757	262.9814148	0.732475424	0.469114872
2003	Steelhead	0.953264578	0.594336337	0.566559777	124.83	125.83	131.38	0.021003143	11887.836	11.26385638	1.853579476	45.84043019	11.0127985	78.11331329	0.986066186	0.97500391	7.259435318	24.45593767	12.92866405	235.6211751	0.933331182	16.62785784	253.9583893	0.711380355	0.424088392
2004	Steelhead	0.94740645	0.569537298	0.53958331	129.55	130.5	136.11	0.020158257	10866.63425	11.20234796	1.863877922	45.61493797	11.46764755	74.43114014	0.993126082	1.025600815	7.061843805	24.73498058	13.61977577	223.0925852	0.94431448	16.66425212	244.2779846	0.68816174	0.401145385
2005	Steelhead	0.912388706	0.531855827	0.48525925	129.42	129.91	135.03	0.020447131	9913.763238	10.81394087	1.857743293	45.77060705	12.68434429	77.80341492	0.98908062	0.972150993	7.260197699	23.95438729	14.23052899	212.6719462	0.941160262	16.06243722	219.6639252	0.626240662	0.347560682
2006	Steelhead	0.966255826	0.662942907	0.640572446	121.7	122.25	126.93	0.020690319	13240.12438	11.93747909	1.589484356	53.59509807	10.23211327	128.5206375	0.963087511	1.018362236	6.694364384	27.8461689	11.63457282	316.1989339	0.878096441	17.32920106	329.8375549	0.764633766	0.503961604
2007	Steelhead	0.924261519	0.582171511	0.538078725	117.89	118.28	123.64	0.021038393	11309.27894	11.28836261	2.012084536	42.2500475	11.57402973	60.92116776	0.98881433	1.032085896	7.264398783	24.36821315	13.11751223	231.7659022	0.940458337	16.90203714	239.1182404	0.666668547	0.404135307
2008	Steelhead	0.94700877	0.604011974	0.572004636	128.88	129.36	135.35	0.020036565																	

Columbia River System Operations Environmental Impact Statement
Appendix E: Fish, Aquatic Macroinvertebrates, and Aquatic Habitat

Year	Species	InRivSurvSNK	InRivSurvLCol	InRivSurv	MedDayLGR	MedDayConfi	MedDayBON	meanTravelTime	meanMigRate	meanTemp	meanFlow	meanSpill	meanGas	SNKTravelTime	SNKMigrate	SNKTemp	SNKFlow	SNKFSpill	SNKGas	LCTravelTime	LCMigRate	LCTemp	LCFlow	LCFSpill	LCGas
1938	Chinook_1	0.9428013	0.629320011	0.593323724	129.62	131.99	136.62	13.12980019	29.43547309	12.9312597	230.0714395	0.918362443	12.00424184	3.458891086	24.76891889	11.4953577	108.5496277	0.960557067	1.14256773	6.989955246	24.18111903	13.50489426	294.9294128	0.842381616	17.72536898
1939	Chinook_1	0.932663434	0.730297054	0.681121359	116.26	119.3	126.63	16.09688574	23.73185555	11.05243015	179.6031669	0.941351069	11.1677865	4.777873665	18.23326605	10.25021286	84.20984497	0.965126467	0.95206461	8.127569884	20.10714516	11.33248631	227.765007	0.89221408	16.67483012
1940	Chinook_1	0.897181013	0.741841107	0.665565756	95.01	101.29	110.58	23.14981412	16.80789933	9.979395594	159.7398491	0.870330636	9.803946665	9.067651533	10.05293569	8.90916481	83.4686203	0.855995822	0.572818279	9.50826332	16.82794299	10.31166538	196.356753	0.817441692	14.14873425
1941	Chinook_1	0.918098565	0.491367568	0.451123859	132.94	135.1	136.18	14.34438361	26.83996943	14.30083254	139.9344474	0.93625385	10.41355865	4.073638529	21.2303918	13.41648827	57.05632095	0.941843772	0.89277029	7.540341422	21.50623326	14.66612307	182.7448807	0.899722715	15.4876922
1942	Chinook_1	0.935438284	0.670121098	0.62685693	135.78	137.98	144.4	14.07071905	28.20495423	12.51990162	185.4200352	0.92574163	11.05964201	4.391121432	20.29452976	11.2254137	82.89598694	0.948317802	0.956099224	7.151454926	23.6046947	13.06309144	235.7948583	0.869799376	16.31995535
1943	Chinook_1	0.935659055	0.711049889	0.665300267	122.41	124.62	130.89	16.04456062	23.97664466	11.5868003	227.2685285	0.914344783	11.7258968	4.952138975	18.10939747	10.18534355	122.8862	0.951875997	1.063215733	7.859501831	21.05050102	12.05805842	286.6865387	0.840241869	17.32282909
1944	Chinook_1	0.931310454	0.589108693	0.548643084	130.65	133.04	140.54	14.26953673	27.78881458	13.11945779	130.5085733	0.93191106	10.07825814	4.167114973	20.84824354	11.71320038	62.59826965	0.926839221	0.863035774	7.637243986	21.52553226	13.79637162	165.9525757	0.90209341	14.91286413
1945	Chinook_1	0.924807161	0.68801211	0.636278526	118.92	122.12	129.37	16.29735523	23.89111577	11.94898605	161.1848962	0.92267225	10.53424805	5.181002282	17.04313545	10.72434158	67.20752563	0.927726293	0.799880028	8.103697516	20.28813519	12.32439089	203.4799296	0.879796724	15.51340143
1946	Chinook_1	0.935184073	0.771318153	0.721324452	110.64	113.62	121.69	17.25354118	22.05161905	10.39500557	251.0249525	0.909397164	12.05411656	5.259769082	16.71379025	9.310554695	114.8619568	0.95593766	0.97758646	8.359643765	19.88627815	10.59841601	320.7272746	0.825312018	17.6318388
1947	Chinook_1	0.927380933	0.689266364	0.639212484	110.45	113.93	121.75	17.2759674	21.89473134	11.5767389	204.6822602	0.931122414	11.50056989	5.478531554	16.12173416	9.992050362	86.89625397	0.962491655	0.955011559	8.238034755	19.6479517	12.04440371	259.0696106	0.870543182	17.0072217
1948	Chinook_1	0.945119325	0.631212744	0.596571363	132.96	134.96	138.9	11.8433664	32.73970281	13.25773478	213.9151862	0.911958673	14.37064889	3.100323163	27.59181269	12.01188374	133.5401215	0.967187107	1.3467103	6.224513762	28.00791802	13.75130812	402.9443919	0.821914375	21.22877169
1949	Chinook_1	0.941611146	0.574706819	0.541150347	126.06	128.17	134.13	12.59286495	30.782015	13.63211877	263.9463283	0.911411801	12.70895403	3.166792646	26.95728627	12.16335049	118.1861816	0.962479687	1.203732204	6.777512379	25.19968191	14.31540887	330.8536174	0.824561338	18.30514701
1950	Chinook_1	0.94036978	0.687408497	0.646418178	132.28	134.4	140.49	13.33911378	29.26868728	12.44174596	208.9338139	0.928749778	11.58676846	3.772573136	22.84777049	11.26592464	89.06238098	0.965813947	1.076886272	7.015434071	24.18215191	12.89964469	267.1746852	0.862238169	17.15840705
1951	Chinook_1	0.940750052	0.646447492	0.608145512	130.78	132.73	139.02	13.08679114	29.5947293	12.93380063	261.100514	0.903174537	12.55835734	3.752009198	23.14820785	11.39031487	105.1453979	0.955452979	1.160851383	6.672856867	25.73017306	13.61551523	341.1260376	0.811197539	18.19406907
1952	Chinook_1	0.948563121	0.725084227	0.687788157	125.29	127.26	133.35	13.51345792	28.65859	11.7980002	288.9339458	0.893868289	12.60081226	3.539834403	24.41712368	10.65001907	157.7332123	0.94629916	1.073069286	7.090015888	24.32481543	12.19655816	355.4608307	0.797111829	18.17847077
1953	Chinook_1	0.932248763	0.669975253	0.6245836	132.34	134.84	141.57	14.5384144	26.94388853	12.46399437	199.0854972	0.920639162	11.33709363	4.667881675	18.88274721	11.04626389	82.66471863	0.950010598	1.003823853	7.169836618	23.44053174	13.06891155	255.7379532	0.856482973	16.66896693
1954	Chinook_1	0.942225263	0.69061057	0.650710726	139.47	141.18	145.82	12.98163103	30.11547434	12.4458174	238.6945724	0.909547099	12.09502762	3.857077681	22.60513913	11.16204472	101.815036	0.952953672	1.094530773	6.61133185	25.98620794	12.98049911	310.9767456	0.828148872	17.71284389
1955	Chinook_1	0.939907352	0.648403469	0.609439188	135.09	137.18	143.18	13.33498262	29.47321137	12.78401143	185.8551423	0.932727316	11.22092761	3.834919341	22.61800312	11.27868443	84.46255035	0.95787344	1.015513134	7.038611092	23.94228091	13.46064043	237.0767568	0.878135989	16.64743392
1956	Chinook_1	0.942830813	0.731503672	0.689684202	117.66	119.99	126.58	14.85357446	25.69955246	11.27465568	302.6483721	0.897261828	13.54893126	4.175037801	20.7840104	10.15770817	138.2622681	0.956456435	1.195939445	7.445017643	22.83812743	11.65659555	391.3129832	0.796564112	19.64556964
1957	Chinook_1	0.93420003	0.712974366	0.666060674	117.2	120.63	126.56	15.64924931	24.26768902	11.50165367	254.7900124	0.91012222	12.48391996	4.874808751	18.01972988	10.44516907	121.3573898	0.949143672	1.010146332	7.500547677	22.04596233	11.88011662	319.1820882	0.8322665871	18.07788976
1958	Chinook_1	0.945098289	0.677667818	0.640462696	127.42	129.53	134.78	12.67661649	30.70322459	12.53825276	265.0110964	0.910099298	12.62663443	3.369606204	25.3395453	11.3269207	118.6450653	0.961831141	1.12254343	6.725796096	25.74195715	12.97789256	334.7067719	0.822039167	18.29989735
1959	Chinook_1	0.937574189	0.618094196	0.579509165	136.17	138.11	143.76	12.90572157	30.07717962	13.26790633	216.0809065	0.925344642	11.94332153	3.689203463	23.2951907	11.81298332	81.67079468	0.968663418	1.168298054	6.700755835	25.34666963	13.89464839	285.3157247	0.851918221	17.72595628
1960	Chinook_1	0.939273595	0.642865181	0.603826289	134.4	136.23	141.48	13.4435164	29.01829826	12.83479146	202.0211225	0.928103643	11.64252291	3.949062288	21.99997941	11.22958927	87.2541687	0.962797773	1.129856777	6.945016883	24.29223141	13.52760204	263.2388763	0.863244593	17.33662446
1961	Chinook_1	0.919747768	0.65404419	0.601555683	118.75	121.99	128.42	16.72839127	23.18204857	12.32017013	178.2271808	0.93108362	11.24308021	5.695669383	15.6826935	10.75580101	61.61362991	0.955645823	0.983410835	7.875345595	20.74029479	12.91482051	236.8989131	0.876157304	16.64345519
1962	Chinook_1	0.936064364	0.701709363	0.656845128	119.62	122.22	129.47	15.28701611	25.12688982	11.84704542	192.7912619	0.937266205	11.51029338	4.443298809	19.54585256	10.53264713	89.14200134	0.971485114	1.115723515	7.819613539	21.16719134	12.25541528	248.4374568	0.877383858	17.22079865
1963	Chinook_1	0.922118709	0.632716658	0.583439868	118.22	121.31	127.83	16.80927831	22.87640296	12.38530724	155.2652032	0.930187894	10.52444322	5.453058347	16.24292243	10.84863815	68.49351196	0.936803067	0.851952267	8.149402574	19.87273529	12.96026754	198.6662725	0.889769624	15.53909707
1964	Chinook_1	0.942494274	0.625559549	0.589586293	133.63	135.81	142.03	12.58996022	31.23691135	13.23946272	214.7156176	0.921702453	11.59369547	3.510752045	24.59205289	11.49808865	92.38935547	0.956769037	1.038137913	6.688321568	25.65391146	13.98641904	273.7887929	0.853331635	17.08172274
1965	Chinook_1	0.941251681	0.53172566	0.500487671	144.43	145.95	145.8	11.5413539	33.98329551	14.02750955	261.5578799	0.899217712	12.33797417	2.765829861	30.83941682	13.28970165	135.6426117	0.950970209	1.166245174	6.350620344	27.22420967	14.34511995	328.2438914	0.805699408	18.00134134
1966	Chinook_1	0.91776341	0.70931603	0.650984298	111.14	115.02	123.18	18.3648573	20.876761	11.05357674	145.3671611	0.936785919	10.34624887	6.198017053	14.27082342	10.03481083	60.78222275	0.945206892	0.850830936	8.658792965	18.55111284	11.40186898	187.0498098	0.898161858	15.28496393
1967	Chinook_1	0.927480631	0.72076884	0.668499139	125.08	128.22	135.3	15.42005945	25.49679496	11.61102343	171.7115816	0.926491231	10.92439246	5.019380093	17.31911221	10.62183495	56.82792053	0.941828096	0.904004383	7.644236095	21.84263557	11.98564021	225.2710597	0.876956294	16.06693236
1968	Chinook_1	0.921347794	0.432473416	0.398458428	139.77	141.64	143.21	12.71497348	30.52794186	15.08551659	169.6152485	0.919785261	10.7282705	3.302830435	25.87403081	14.55237217	69.4795929	0.937691772	0.969315243	6.955081396	23.64994323	15.31961234	219.468928	0.864755889	15.82570632
1969	Chinook_1	0																							

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Year	Species	InRivSurvSNK	InRivSurvLCol	InRivSurv	MedDayLGR	MedDayConfl	MedDayBON	meanTravelTime	meanMigRate	meanTemp	meanFlow	meanFSpill	meanGas	SNKTravelTime	SNKMigRate	SNKTemp	SNKFlow	SNKFSpill	SNKGas	LCTravelTime	LCMigRate	LCTemp	LCFlow	LCFSpill	LCGas
1988	Chinook_1	0.907851691	0.733173252	0.665612577	109.15	112.86	121.25	20.48248313	19.37168307	10.49605928	140.0291195	0.933873377	10.27026531	7.910552666	11.72246198	9.335994148	59.47561111	0.933925879	0.779426765	8.886822343	18.03544632	10.89973752	183.347702	0.900767098	15.20299387
1989	Chinook_1	0.940908683	0.568672679	0.535069062	141.85	143.9	148.52	12.65472893	30.90013625	13.53968722	185.3334454	0.938927868	11.56930849	3.409482844	24.97608008	11.81730518	78.12469025	0.969640326	1.162176704	6.840721935	24.70346833	14.29802497	242.5163371	0.882798155	17.32834816
1990	Chinook_1	0.923189594	0.434070986	0.400729817	131.6	133.82	138.25	13.07381677	29.62345846	14.92803274	157.9730331	0.944407059	11.13117405	3.431225017	24.8303309	13.88313637	62.96385422	0.96513468	1.137556171	7.134627737	22.93533546	15.34020456	212.437439	0.899337659	16.71860949
1991	Chinook_1	0.92111316	0.640586694	0.590052834	123.59	126.65	131.83	15.96501416	24.35283784	12.54200969	184.3834122	0.925236097	11.3217377	5.417795964	16.39552016	11.0617485	60.4889595	0.952485096	1.000993538	7.54182338	21.85990735	13.12295262	250.767156	0.865146806	16.7612319
1992	Chinook_1	0.910810052	0.544127735	0.495597011	121.11	123.73	128.39	15.89444603	23.88094742	13.50608451	143.9428079	0.933919792	10.49935906	4.775075763	18.23057276	12.79803829	49.30284119	0.939830983	0.874329376	7.977134332	20.15477689	13.73491716	192.6713613	0.895954231	15.60594257
1993	Chinook_1	0.933821883	0.728200206	0.680009288	120.74	123.53	131.11	15.52881972	24.98698997	11.35056087	181.449598	0.921542896	10.83734051	4.602341816	18.79821446	10.44984303	78.15470886	0.929125226	0.757965136	7.986709952	20.85676949	11.64633528	222.5053584	0.875995984	15.81847413
1994	Chinook_1	0.924724046	0.478607948	0.442580278	128.68	130.92	136.2	13.47905357	28.81354085	14.07383565	159.7593907	0.941056209	11.13523851	3.671446666	23.33482813	12.9633976	60.64072266	0.958910322	1.078376007	7.258037418	22.69643285	14.63310623	213.3847427	0.896706412	16.663836
1995	Chinook_1	0.931189519	0.648575576	0.603946778	127.36	129.61	135.26	15.14827235	25.44026998	12.49478258	191.1623753	0.921734312	11.06263689	4.729979694	18.64473668	11.09065399	92.08553772	0.945824325	0.969075108	7.474182501	22.08428898	13.07465458	241.1202189	0.862526973	16.31427908
1996	Chinook_1	0.936483339	0.536659398	0.502572585	140.7	142.07	143.92	11.70786005	33.25943092	14.41256693	259.6054459	0.900391557	12.41698228	2.894296721	29.45435112	13.74603443	122.2700714	0.951605511	1.168589115	6.356456138	27.03757343	14.66434844	331.6889496	0.80790927	18.04236031
1997	Chinook_1	0.946430549	0.56759401	0.537188311	134.64	136.19	138.76	11.04769084	35.2216239	13.94577312	359.0536575	0.891592064	15.3644899	2.685642488	31.7096264	12.71912651	161.8798187	0.961983311	1.42484169	5.845867239	30.33914993	14.50276311	462.907252	0.778728803	22.30342436
1998	Chinook_1	0.926089561	0.673411068	0.62363896	116.01	118.99	125.84	16.50233982	23.28649212	12.15619176	221.6330828	0.909726718	11.57903406	5.388713598	16.47037562	10.52623863	89.67572021	0.940230286	0.901768494	7.827654161	21.11601171	12.72366683	281.9791361	0.839171072	16.77839613
1999	Chinook_1	0.933498789	0.6440518	0.601221575	121.06	123.27	129.55	15.34908157	24.84555804	12.51363856	208.5366336	0.926728249	11.65984389	4.460633345	19.59851642	10.97312603	99.10372162	0.96206826	1.083430195	7.75849174	21.18066698	13.11939955	269.2292633	0.860644897	17.36858368
2000	Chinook_1	0.934128531	0.491964452	0.459558031	131.06	133.15	136.33	12.89917924	30.00482797	13.99807903	192.2661029	0.938069833	11.68468107	3.307569943	25.86380102	12.75286827	87.11137543	0.971442997	1.214183807	7.015308201	23.6310689	14.55499999	248.8124034	0.87929367	17.53622659
2001	Chinook_1	0.901998114	0.668820721	0.603275029	110.85	115.27	123.55	20.30370936	19.65049962	11.61719356	106.9310028	0.902305322	9.162345988	7.732205547	11.81471181	9.812289238	40.84489517	0.877699685	0.642381001	9.065834157	17.72747057	12.18252468	138.8234444	0.87396268	13.34401735
2002	Chinook_1	0.930664983	0.692019062	0.644037909	119.9	122.82	129.7	15.680272	24.53646591	11.87192815	177.3372116	0.940441281	11.39164284	4.828399539	18.02926746	10.54598541	70.11482849	0.967599273	1.07222271	7.846530214	20.92437974	12.28840812	234.8616511	0.888030926	17.06499465
2003	Chinook_1	0.933996581	0.625510205	0.584224393	130.58	133.05	140.1	13.88954074	27.98336534	12.94375944	189.1425182	0.933400933	11.46981124	4.058642268	21.32613473	11.54360847	76.90997314	0.95915066	1.04174099	7.218223877	23.03570869	13.57815647	240.9558792	0.878643284	16.90962474
2004	Chinook_1	0.911677585	0.720735875	0.657078742	107.4	111.8	120.19	20.04435213	19.42595846	10.84661627	156.8628693	0.934568724	10.65870864	7.491854139	12.13189929	9.239259338	60.71099243	0.944861388	0.831694698	8.787384219	18.19309401	11.32144101	202.0887909	0.893276095	15.75589188
2005	Chinook_1	0.920659327	0.577970625	0.532114046	122.67	125.34	131.08	15.45239247	24.87703169	13.42231921	160.7789759	0.934611333	10.75613764	4.737477459	18.55627983	12.15538731	67.1325058	0.947854865	0.95613308	7.759533256	20.92396858	13.89541594	206.7044169	0.890881052	15.93471718
2006	Chinook_1	0.944676789	0.727941282	0.687669233	121.51	123.64	130.82	14.39976376	26.76108028	11.59064014	235.8189278	0.921862606	11.9877989	3.853836223	22.4557847	10.42948494	127.8444931	0.962502337	1.132489204	7.580875888	22.13471165	11.95247412	291.8727773	0.848927726	17.79081662
2007	Chinook_1	0.920351544	0.605417304	0.55719675	120.87	123.23	129.47	15.70214823	24.37049418	13.15608788	184.35333156	0.936246174	11.46169359	4.957941048	17.81328382	11.89204922	68.44199371	0.965548635	1.094354916	7.662223019	21.24761167	13.6193374	243.8244171	0.879951119	17.13318952
2008	Chinook_1	0.902274752	0.731506469	0.660019817	107.41	112.13	120.36	20.81229638	18.99225373	10.70697124	141.630179	0.911723226	9.860057541	8.151316971	11.1369262	9.57006855	60.82829208	0.902300012	0.678269243	8.886300884	18.05682375	11.04602242	181.1583989	0.875437617	14.2479349

9 Table 4-8. Snake River_MO3_Chinook_SAL_W_Wildfish Raw_Data

Year	Species	InRivSurvSNK	InRivSurvLCol	InRivSurv	MedDayLGR	MedDayConfl	MedDayBON	meanTravelTime	meanMigRate	meanTemp	meanFlow	meanFSpill	meanGas	SNKTravelTime	SNKMigRate	SNKTemp	SNKFlow	SNKFSpill	SNKGas	LCTravelTime	LCMigRate	LCTemp	LCFlow	LCFSpill	LCGas	BonFlow
SCN MO3-RESSIM-SAL-W																										
1929	Chinook_1	0.928357245	0.660388861	0.613076784	124.99	127.68	135.31	15.61414757	25.39925313	12.249997	116.4245761	0.913621298	9.445647052	4.620796092	18.69584258	11.09575596	54.09363785	0.898328197	0.75318675	8.32892593	19.66939881	12.66242043	143.7363892	0.883176486	13.83508452	155.6888428
1930	Chinook_1	0.905715686	0.667377405	0.604454184	103.93	109.4	117.67	20.84318539	18.6661567	11.02845594	119.3109662	0.921401339	9.321961948	7.829573594	11.69708146	9.682554626	59.33450851	0.908602405	0.663420486	9.104318202	17.41190759	11.44944302	148.4239655	0.892768006	13.48886887	156.8544769
1931	Chinook_1	0.897166759	0.67031142	0.601381124	106.55	111.67	120	21.5591597	18.41557936	11.10570138	104.4473452	0.907451957	8.917138253	8.50026194	10.74549776	9.566019058	42.97081604	0.891246021	0.655017328	9.243554853	17.21636423	11.56169287	133.8507538	0.874683022	12.98325332	142.3947296
1932	Chinook_1	0.929680119	0.737970911	0.686076884	117.64	120.5	127.95	16.22781984	23.56081621	11.40538113	210.8462219	0.923208679	11.6433943	4.995455891	17.43620728	10.32642632	82.57201233	0.960838521	1.024285984	7.979636677	20.75241093	11.69129944	272.749911	0.853455196	17.2168088	288.116394
1933	Chinook_1	0.927657514	0.617036848	0.572398868	131.16	133.78	140.86	14.22815643	27.68639439	13.04152441	163.1537566	0.942810446	11.26976153	4.46476157	19.48336896	11.63727741	56.05530777	0.96332314	1.101433849	7.250796698	22.91051072	13.71642288	217.2336884	0.897121797	16.87941408	226.2290649
1934	Chinook_1	0.921984172	0.634071161	0.584603574	114.54	117.26	123.07	16.62890626	22.66440404	12.37452568	227.4601075	0.909600449	11.9346512	5.161730133	16.98495696	11.14434586	78.89875641	0.953875625	1.109517002	7.935626559	20.59129958	12.7882568	307.5053304	0.827504883	17.69172303	314.8951111
1935	Chinook_1	0.928366336	0.588027961	0.545905364	125.64	128.12	135.26	14.34832015	27.11159217	13.26330921	165.5472161	0.940769945	11.14373895	4.243967913	20.44746447	11.80034485	62.74397888	0.959525144	1.038751221	7.448547184	22.12645172	13.95136674	216.6394374	0.895525744	16.63037157	228.8704224
1936	Chinook_1	0.94292368	0.725616399	0.684200886	116.42	118.93	126.33	15.22456141	25.09445139	11.10381896	235.7620168	0.923186983	11.86958299	4.132692635	20.95292767	10.02758312	127.4037766	0.967074478	1.1084198	7.8848138	21.1173631	11.44130691	291.1449331	0.848207633	17.60522461	302.5773315
1937	Chinook_1	0.919801304	0.668925496	0.615278543	124.7	127.36	134.46	16.82828362	23.77596712	12.18555219	134.1540105	0.925462646	10.08149457	5.835220024	15.54447275	10.68247204	54.94858475	0.921893406	0.810753727	8.132963262	20.14746941	12.70344369	171.6011963	0.891169012	14.82595269	185.3708344
1938	Chinook_1	0.9428013	0.629320011	0.593323724	129.62	131.99	136.62	13.12980019	29.43547309	12.9312597	230.0714395	0.918362443	12.00424184	3.458891086	24.76891889	11.4953577	108.5496277	0.960557067	1.14256773	6.989955246	24.18111903	13.50489426	294.9294128	0.842381616	17.72536898	304.2151794
1939	Chinook_1	0.932663434	0.730297054	0.681121359	116.26	119.3	126.63	16.09688574	23.73185555	11.05243015	179.6031669	0.941351069	11.1677865	4.777873665	18.23326605	10.25021286	84.20984497	0.965126467	0.95206461	8.127569884	20.10714516	11.33248631	227.765007	0.89221408	16.67483012	237.5539093
1940	Chinook_1	0.897181013	0.741841107	0.665565756	95.01	101.29	110.58	23.14981412	16.80789933	9.979395594	159.7398491	0.870330636	9.803946665	9.067651533	10.05293569	8.90916481	83.4686203	0.855995822	0.572818279	9.50826332	16.82794299	10.31166538	196.356753	0.817441692	14.14873425	207.4420776
1941	Chinook_1	0.918098565	0.491367568	0.451123859	132.94	135.1	136.18	14.34438361	26.83996943	14.30083254	139.9344474	0.93625385	10.41355865	4.073638529	21.2303918	13.41648827	57.05632095	0.941843772	0.89277029	7.540341422	21.50623326	14.66612307	182.7448807	0.899722715	15.4876922	189.7191925
1942	Chinook_1	0.935438284	0.670121098	0.62685693	135.78	137.98	144.4	14.07071905	28.20495423	12.51990162	185.4200352	0.92574163	11.05964201	4.391121432	20.29452976	11.2254137	82.89598694	0.948317802	0.956099224	7.151454926	23.6046947	13.06309144	235.7948583	0.869799376	16.31995535	249.0049591
1943	Chinook_1	0.935659055	0.711049889	0.626300267	122.41	124.62	130.89	16.04456062	23.97664466	11.5868003	227.2685285	0.914344783	11.2598968	4.952138975	18.10939747	10.18534355	122.8862	0.951875997	1.063215733	7.859501831	21.05050102	12.05805842	286.6865387	0.840241869	17.32282909	291.9403381
1944	Chinook_1	0.931310454	0.589108693	0.548643084	130.65	133.04	140.54	14.26953673	27.78881458	13.11945779	130.5085733	0.93191106	10.07825814	4.167114973	20.84824354	11.71320038	62.59826965	0.926839221	0.863035774	7.637243986	21.52553226	13.79637162	165.9525757	0.90209341	14.91286413	173.5774841
1945	Chinook_1	0.924807161	0.68801211	0.636278526	118.92	122.12	129.37	16.29735523	23.89111577	11.94898605	161.1848962	0.92267225	10.53424805	5.181002282	17.04313545	10.72434158	67.20752563	0.927726293	0.799880028	8.103697516	20.28813519	12.32439089	203.4799296	0.879796724	15.51340143	221.3555756

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Appendix E: Fish, Aquatic Macroinvertebrates, and Aquatic Habitat

Year	Species	InRivSurvSNK	InRivSurvLCol	InRivSurv	MedDayLGR	MedDayConfl	MedDayBON	meanTravelTime	meanMigRate	meanTemp	meanFlow	meanFSpill	meanGas	SNKTravelTime	SNKMigRate	SNKTemp	SNKFlow	SNKFSpill	SNKGas	LCTravelTime	LCMigRate	LCTemp	LCFlow	LCFSpill	LCGas	BonFlow
1946	Chinook_1	0.935184073	0.771318153	0.721324452	110.64	113.62	121.69	17.25354118	22.05161905	10.39500557	251.0249525	0.909397164	12.05411656	5.259769082	16.71379025	9.310554695	114.8619568	0.95593766	0.97758646	8.359643765	19.88627815	10.59841601	320.7272746	0.825312018	17.6318388	335.7413025
1947	Chinook_1	0.927380933	0.689266364	0.639212484	110.45	113.93	121.75	17.2759674	21.89473134	11.5767389	204.6822602	0.931122414	11.50056989	5.478531554	16.12173416	9.992050362	86.89625397	0.962491655	0.955011559	8.238034755	19.6479517	12.04440371	259.0696106	0.870543182	17.0072217	274.3099976
1948	Chinook_1	0.945119325	0.631212744	0.596571363	132.96	134.96	138.9	11.8433664	32.73970281	13.25773478	313.9151862	0.911958673	14.37064889	3.100323163	27.59181269	12.01188374	133.5401215	0.967187107	1.3467103	6.224513762	28.00791802	13.75130812	402.9443919	0.821914375	21.22877169	422.6490479
1949	Chinook_1	0.941611146	0.574706819	0.541150347	126.06	128.17	134.13	12.59286495	30.782015	13.63211877	263.9463283	0.911411801	12.70895403	3.166792646	26.95728627	12.16335049	118.1861816	0.962479687	1.203732204	6.777512379	25.19968191	14.31540887	330.8536174	0.824561338	18.30514701	355.4908752
1950	Chinook_1	0.94036978	0.687408497	0.646418178	132.28	134.4	140.49	13.33911378	29.26868728	12.44174596	208.9338139	0.928749778	11.58676846	3.772573136	22.84777049	11.26592464	89.06238098	0.965813947	1.076886272	7.015434071	24.18215191	12.89964469	267.1746852	0.862238169	17.15840705	284.1130066
1951	Chinook_1	0.940750052	0.646447492	0.608145512	130.78	132.73	139.02	13.08679114	29.5947293	12.93380063	261.100514	0.903174537	12.55835734	3.752009198	23.14820785	11.39031487	105.1453979	0.955452979	1.160851383	6.672856867	25.73017306	13.61551523	341.1260376	0.811197539	18.19406907	356.9513245
1952	Chinook_1	0.948563121	0.725084227	0.687788157	125.29	127.26	133.35	13.51345792	28.65859	11.7980002	288.9339458	0.893868289	12.60081226	3.539834403	24.41712368	10.65001907	157.7332123	0.94629916	1.073069286	7.090015888	24.32481543	12.19655816	355.4608307	0.797111829	18.17847077	369.7636108
1953	Chinook_1	0.932248763	0.669975253	0.6245836	132.34	134.84	141.57	14.5384144	26.94388853	12.46399437	199.0854972	0.920639162	11.33709363	4.667881675	18.88274721	11.04626389	82.66471863	0.950010598	1.003823853	7.169836618	23.44053174	13.06891155	255.7379532	0.856482973	16.66896693	270.6851196
1954	Chinook_1	0.942225263	0.69061057	0.650710726	139.47	141.18	145.82	12.98163103	30.11547434	12.4458174	238.6945724	0.909547099	12.09502762	3.857077681	22.60513913	11.16204472	101.815036	0.952953672	1.094530773	6.61133185	25.98620794	12.98049911	310.9767456	0.828148872	17.71284389	321.0226135
1955	Chinook_1	0.939907352	0.648403469	0.609439188	135.09	137.18	143.18	13.33498262	29.47321137	12.78401143	185.8551423	0.932727316	11.22092761	3.834919341	22.61800312	11.27868443	84.46255035	0.95787344	1.015513134	7.038611092	23.94228091	13.46064043	237.0767568	0.878135989	16.64743392	249.609375
1956	Chinook_1	0.942830813	0.731503672	0.689684202	117.66	119.99	126.58	14.85357446	25.69955246	11.27465568	302.6483721	0.897261828	13.54893126	4.175037801	20.7840104	10.157770817	138.2622681	0.956456435	1.195939445	7.445017643	22.83812743	11.65659555	391.3129832	0.796564112	19.64556964	407.2499695
1957	Chinook_1	0.93420003	0.712974366	0.666060674	117.2	120.63	126.56	15.64924931	24.26768902	11.50165367	254.7900124	0.91012222	12.48391996	4.874808751	18.01972988	10.44516907	121.3573898	0.949143672	1.010146332	7.500547677	22.04596233	11.88011662	319.1820882	0.832665871	18.07788976	335.2315063
1958	Chinook_1	0.945098289	0.677667818	0.640462696	127.42	129.53	134.78	12.67661649	30.70322459	12.53825276	265.0110964	0.910099298	12.62663443	3.369606204	25.3395453	11.3269207	118.6450653	0.961831141	1.12254343	6.725796096	25.74195715	12.97789256	334.7067719	0.822039167	18.29989735	355.9057922
1959	Chinook_1	0.937574189	0.618094196	0.579509165	136.17	138.11	143.76	12.90572157	30.07717962	13.26790633	216.0809065	0.925344642	11.94332153	3.689203463	23.2951907	11.81298332	81.67079468	0.968663418	1.168298054	6.700755835	25.34666963	13.89464839	285.3157247	0.851918221	17.72595628	295.8647461
1960	Chinook_1	0.939273595	0.642865181	0.603826289	134.4	136.23	141.48	13.4435164	29.01829826	12.83479146	202.0211225	0.928103643	11.64252291	3.949062288	21.99997941	11.22958927	87.2541687	0.962797773	1.129856777	6.945016883	24.29223141	13.52760204	263.2388763	0.863244593	17.33662446	272.1536255
1961	Chinook_1	0.919747768	0.65404419	0.601555683	118.75	121.99	128.42	16.72839127	23.18204857	12.32017013	178.2271808	0.93108362	11.24308021	5.695669383	15.6826935	10.75580101	61.61362991	0.955645823	0.983410835	7.875345595	20.74029479	12.91482051	236.8989131	0.876157304	16.64345519	246.2315369
1962	Chinook_1	0.936064364	0.701709363	0.656845128	119.62	122.22	129.47	15.28701611	25.12688982	11.84704542	192.7912619	0.937266205	11.51029338	4.443298809	19.54585256	10.53264713	89.14200134	0.971485114	1.115723515	7.819613539	21.16719134	12.25541528	248.4374568	0.877383858	17.22079865	254.2403564
1963	Chinook_1	0.922118709	0.632716658	0.583439868	118.22	121.31	127.83	16.80927831	22.87640296	12.38530724	155.2652032	0.930187894	10.52444322	5.453058347	16.24292243	10.84863815	68.49351196	0.936803067	0.851952267	8.149402574	19.87273529	12.96026754	198.6662725	0.889769624	15.53909707	208.2541809
1964	Chinook_1	0.942494274	0.625559549	0.589586293	133.63	135.81	142.03	12.58996022	31.23691135	13.23946272	214.7156176	0.921702453	11.59369547	3.510752045	24.59205289	11.49808865	92.38935547	0.956769037	1.038137913	6.688321568	25.65391146	13.98641904	273.7887929	0.853331635	17.08172274	288.8950806
1965	Chinook_1	0.941251681	0.53172566	0.500487671	144.43	145.95	145.8	11.5413539	33.98329551	14.02750955	261.5578799	0.899217712	12.33797417	2.765829861	30.83941682	13.28970165	135.6426117	0.950970209	1.166245174	6.350620344	27.22420967	14.34511995	328.2438914	0.805699408	18.00134134	335.8592224
1966	Chinook_1	0.91776341	0.70931603	0.650984298	111.14	115.02	123.18	18.3648573	20.876761	11.05357674	145.3671611	0.936785919	10.34624887	6.198017053	14.27082342	10.03481083	60.78222275	0.945206892	0.850830936	8.658792965	18.55111284	11.40186898	187.0498098	0.898161858	15.28496393	197.3336334
1967	Chinook_1	0.927480631	0.72076884	0.668499139	125.08	128.22	135.3	15.42005945	25.49679496	11.61102343	171.7115816	0.926491231	10.92439246	5.019380093	17.31911221	10.62183495	56.82792053	0.941828096	0.904004383	7.644236095	21.84263557	11.98564021	225.2710597	0.876956294	16.06693236	238.6222229
1968	Chinook_1	0.921347794	0.432473416	0.398458428	139.77	141.64	143.21	12.71497348	30.52794186	15.08551659	169.6152485	0.919785261	10.7282705	3.302830435	25.87403081	14.55237217	69.4795929	0.937691772	0.969315243	6.955081396	23.64994323	15.31961234	219.468928	0.864755889	15.82570632	229.3779144
1969	Chinook_1	0.937039861	0.679528951	0.636745714	117.41	119.97	126.74	15.46070144	24.61449907	12.05850513	246.300348	0.91200327	12.24280749	4.547307834	19.23751374	10.33544292	112.4046646	0.961330724	1.145501614	7.66193717	21.70353055	12.68593597	315.6274719	0.826899171	17.97530365	322.8534546
1970	Chinook_1	0.933650678	0.69065435	0.644829902	127.1	129.39	135.97	14.80566791	26.38582776	12.04041215	179.9658661	0.914855961	10.68964471	4.516891666	19.27573168	10.89266911	86.61368408	0.929344296	0.861142731	7.557863615	22.07096482	12.48099995	225.1454442	0.860210627	15.69011251	234.0076141
1971	Chinook_1	0.950421234	0.636456445	0.60490172	138.89	140.6	144.3	10.77596619	36.49665958	13.47600072	325.1509432	0.884797924	13.86473915	2.661568828	31.93759469	12.33267479	152.385495	0.957174885	1.256460953	5.784659103	31.10767442	13.95049334	419.1665192	0.766882931	19.87914181	424.7606201
1972	Chinook_1	0.942491373	0.649117034	0.611787204	125.5	127.69	133.18	13.03607337	29.3573705	12.96499518	280.9304395	0.912703148	13.41989613	3.54624708	24.20599601	11.46660709	119.6628113	0.97017132	1.250487137	6.711715788	25.29125163	13.54101864	365.9802806	0.821164727	19.73440361	368.1121521
1973	Chinook_1	0.913193272	0.611634707	0.558540699	121.06	124.33	130.03	17.34924465	22.76162748	12.9716234	122.4352643	0.908939417	9.590033531	6.078401223	14.72326771	11.07201538	50.61755295	0.902614748	0.808424759	8.245299086	19.68059114	13.04298321	158.3396784	0.868679911	14.16824961	165.3374481
1974	Chinook_1	0.945961269	0.604379063	0.571719185	135.51	137.44	142.07	11.51614597	33.81150239	13.72167982	304.6633977	0.893124142	13.60874588	2.917803772	29.21484027	12.35430679	135.994458	0.956823778	1.263627911	6.125857674	28.68114484	14.3077693	396.9584961	0.786602904	19.77946806	401.2987976
1975	Chinook_1	0.94676303	0.609644962	0.577189311	145.26	147.18	151.03	11.29261836	34.80044401	13.55729328	257.3763172	0.907076223	12.47009509	2.866186619	29.72577534	12.36120605	125.9185928	0.960694695	1.197625542	6.155119143	28.29045					

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Appendix E: Fish, Aquatic Macroinvertebrates, and Aquatic Habitat

Year	Species	InRivSurvSNK	InRivSurvLCol	InRivSurv	MedDayLGR	MedDayConfl	MedDayBON	meanTravelTime	meanMigRate	meanTemp	meanFlow	meanFSpill	meanGas	SNKTravelTime	SNKMigRate	SNKTemp	SNKFlow	SNKFSpill	SNKGas	LCTravelTime	LCMigRate	LCTemp	LCFlow	LCFSpill	LCGas	BonFlow
1996	Chinook_1	0.936483339	0.536659398	0.502572585	140.7	142.07	143.92	11.70786005	33.25943092	14.41256693	259.6054459	0.900391557	12.41698228	2.894296721	29.45435112	13.74603443	122.2700714	0.951605511	1.168589115	6.356456138	27.03757343	14.66434844	331.6889496	0.80790927	18.04236031	342.5517273
1997	Chinook_1	0.946430549	0.56759401	0.537188311	134.64	136.19	138.76	11.04769084	35.2216239	13.94577312	359.0536575	0.891592064	15.3644899	2.685642488	31.7096264	12.71912651	161.8798187	0.961983311	1.42484169	5.845867239	30.33914993	14.50276311	462.907252	0.778728803	22.30342436	472.0581055
1998	Chinook_1	0.926089561	0.673411068	0.62363896	116.01	118.99	125.84	16.50233982	23.28649212	12.15619176	221.6330828	0.909726718	11.57903406	5.388713598	16.47037562	10.52623863	89.67572021	0.940230286	0.901768494	7.827654161	21.11601171	12.72366683	281.9791361	0.839171072	16.77839613	300.8494873
1999	Chinook_1	0.933498789	0.6440518	0.601221575	121.06	123.27	129.55	15.34908157	24.84555804	12.51363856	208.5366336	0.926728249	11.65984389	4.460633345	19.59851642	10.97312603	99.10372162	0.96206826	1.083430195	7.75849174	21.18066698	13.11939955	269.2292633	0.860644897	17.36858368	273.2830505
2000	Chinook_1	0.934128531	0.491964452	0.459558031	131.06	133.15	136.33	12.89917924	30.00482797	13.99807903	192.2661029	0.938069833	11.68468107	3.307569943	25.86380102	12.75286827	87.11137543	0.971442997	1.214183807	7.015308201	23.6310689	14.55499999	248.8124034	0.87929367	17.53622659	256.7235718
2001	Chinook_1	0.901998114	0.668820721	0.603275029	110.85	115.27	123.55	20.30370936	19.65049962	11.61719356	106.9310028	0.902305322	9.162345988	7.732205547	11.81471181	9.812289238	40.84489517	0.877699685	0.642381001	9.065834157	17.72747057	12.18252468	138.8234444	0.87396268	13.34401735	150.6756744
2002	Chinook_1	0.930664983	0.692019062	0.644037909	119.9	122.82	129.7	15.680272	24.53646591	11.87192815	177.3372116	0.940441281	11.39164284	4.828399539	18.02926746	10.54598541	70.11482849	0.967599273	1.07222271	7.846530214	20.92437974	12.28840812	234.8616511	0.888030926	17.06499465	242.4504547
2003	Chinook_1	0.933996581	0.625510205	0.584224393	130.58	133.05	140.1	13.88954074	27.98336534	12.94375944	189.1425182	0.933400933	11.46981124	4.058642268	21.32613473	11.54360847	76.90997314	0.95915066	1.04174099	7.218223877	23.03570869	13.57815647	240.9558792	0.878643284	16.90962474	260.7068481
2004	Chinook_1	0.911677585	0.720735875	0.657078742	107.4	111.8	120.19	20.04435213	19.42595846	10.84661627	156.8628693	0.934568724	10.65870864	7.491854139	12.13189929	9.239259338	60.71099243	0.944861388	0.831694698	8.787384219	18.19309401	11.32144101	202.0887909	0.893276095	15.75589188	219.9562683
2005	Chinook_1	0.920659327	0.577970625	0.532114046	122.67	125.34	131.08	15.45239247	24.87703169	13.42231921	160.7789759	0.934611333	10.75613764	4.737477459	18.55627983	12.15538731	67.1325058	0.947854865	0.95613308	7.759533256	20.92396858	13.89541594	206.7044169	0.890881052	15.93471718	216.4258423
2006	Chinook_1	0.944676789	0.727941282	0.687669233	121.51	123.64	130.82	14.39976376	26.76108028	11.59064014	235.8189278	0.921862606	11.9877989	3.853836223	22.4557847	10.42948494	127.8444931	0.962502337	1.132489204	7.580875888	22.13471165	11.95247412	291.8727773	0.848927726	17.79081662	297.8620911
2007	Chinook_1	0.920351544	0.605417304	0.55719675	120.87	123.23	129.47	15.70214823	24.37049418	13.15608788	184.3533156	0.936246174	11.46169359	4.957941048	17.81328382	11.89204922	68.44199371	0.965548635	1.094354916	7.662223019	21.24761167	13.6193374	243.8244171	0.879955119	17.13318952	253.0918427
2008	Chinook_1	0.902274752	0.731506469	0.660019817	107.41	112.13	120.36	20.81229638	18.99225373	10.70697124	141.630179	0.911723226	9.860057541	8.151316971	11.1369262	9.57006855	60.82829208	0.902300012	0.678269243	8.886300884	18.05682375	11.04602242	181.1583989	0.875437617	14.2479349	192.9043579

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Table 4-9. Snake River_MO3_Chinook_SAL_HW_Wildfish Raw_Data

Year	Species	InRivSurvSNK	InRivSurvLCol	InRivSurv	MedDayLGR	MedDayConfl	MedDayBON	SNKTravelTime	SNKMigRate	SNKTemp	SNKFlow	SNKFSpill	SNKGas	LCTravelTime	LCMigRate	LCTemp	LCFlow	LCFSpill	LCGas	BonFlow	monte_q975	monte_q025
SCN MO3-RESSIM-SAL-HW																						
1929	Chinook_1	0.928357245	0.663241138	0.615724715	124.99	127.68	135.22	4.620796092	18.69584258	11.09575596	54.09363785	0.926754498	0.75318675	8.239862502	19.73869295	12.64982144	143.4582901	0.897204896	13.82458091	155.3191376	0.721357667	0.479128455
1930	Chinook_1	0.905715686	0.669794688	0.606643556	103.93	109.4	117.55	7.829573594	11.69708146	9.682554626	59.33450851	0.933146691	0.663420486	9.006323993	17.48631561	11.43564685	148.2828293	0.905412883	13.47640864	156.6886139	0.667089083	0.493489616
1931	Chinook_1	0.897166759	0.673322238	0.60408233	106.55	111.67	119.89	8.50026194	10.74549776	9.566019058	42.97081604	0.917611587	0.655017328	9.133262418	17.29348145	11.54120938	133.7082278	0.888176262	12.97230148	142.1733398	0.68359845	0.506085085
1932	Chinook_1	0.929680119	0.738292445	0.686375809	117.64	120.5	127.92	4.995455891	17.43620728	10.32642632	82.57201233	0.970048988	1.024285984	7.953401983	20.77201338	11.68748871	272.6408437	0.863793353	17.21590281	287.9810181	0.775746599	0.561399976
1933	Chinook_1	0.927657514	0.618050463	0.573339156	131.16	133.78	140.84	4.46476157	19.48336896	11.63727741	56.05530777	0.977275312	1.101433849	7.21811083	22.94945364	13.71609894	217.1445516	0.905762891	16.87788757	226.084259	0.689152871	0.452978439
1934	Chinook_1	0.921984172	0.63430988	0.584823669	114.54	117.26	123.05	5.161730133	16.98495696	11.14434586	78.89875641	0.962951398	1.109517002	7.910318844	20.61534151	12.78478209	307.4966736	0.842089842	17.69121091	314.8917542	0.655469419	0.491222539
1935	Chinook_1	0.928366336	0.589334152	0.547117987	125.64	128.12	135.22	4.243967913	20.44746447	11.80034485	62.74397888	0.97624929	1.038751221	7.412624091	22.16636332	13.94932238	216.542689	0.904879669	16.62836742	228.7690125	0.66520685	0.41529457
1936	Chinook_1	0.94292368	0.725787635	0.684362348	116.42	118.93	126.3	4.132692635	20.95292767	10.02758312	127.4037766	0.977493989	1.1084198	7.855603978	21.14027477	11.43790976	291.1034139	0.861323029	17.60401789	302.5303955	0.747185788	0.578085168
1937	Chinook_1	0.919801304	0.671146326	0.617321266	124.7	127.36	134.41	5.835220024	15.54447275	10.68247204	54.94858475	0.945712519	0.810753727	8.06501469	20.20556713	12.69368696	171.4309845	0.902765075	14.81843249	185.1851654	0.718340843	0.486177493
1938	Chinook_1	0.9428013	0.629521195	0.5935134	129.62	131.99	136.6	3.458891086	24.76891889	11.4953577	108.5496277	0.969272459	1.14256773	6.970343128	24.20331774	13.50309261	294.8815918	0.855849624	17.72454214	304.1505737	0.68442386	0.500519153
1939	Chinook_1	0.932663434	0.731213437	0.681976035	116.26	119.3	126.59	4.777873665	18.23326605	10.25021286	84.20984497	0.97961868	0.95206461	8.087913424	20.14072318	11.32936859	227.6637472	0.901059459	16.67254194	237.4466248	0.743088443	0.565992173
1940	Chinook_1	0.897181013	0.742712704	0.666347736	95.01	101.29	110.51	9.067651533	10.05293569	8.90916481	83.4686203	0.863576818	0.572818279	9.460835293	16.85600007	10.30773735	196.2595113	0.822981685	14.14470164	207.3538208	0.727145559	0.527705986
1941	Chinook_1	0.918098565	0.493396161	0.452986307	132.94	135.1	136.13	4.073638529	21.2303918	13.41648827	57.05632095	0.962566257	0.89277029	7.49218528	21.56433934	14.66070016	182.6404419	0.910226603	15.4824791	189.6040039	0.579117487	0.338307767
1942	Chinook_1	0.935438284	0.671149153	0.627818612	135.78	137.98	144.35	4.391121432	20.29452976	11.2254137	82.89598694	0.965047085	0.956099224	7.113450147	23.64040405	13.0600117	235.5717392	0.881979436	16.31633027	248.7467804	0.714020939	0.532304464
1943	Chinook_1	0.935659055	0.711297359	0.665531815	122.41	124.62	130.88	4.952138975	18.10939747	10.18534355	122.8862	0.960627377	1.063215733	7.834138677	21.07599561	12.05594778	286.7305196	0.853049695	17.32240311	291.9794312	0.749021977	0.563169822
1944	Chinook_1	0.931310454	0.590925301	0.55033491	130.65	133.04	140.48	4.167114973	20.84824354	11.71320038	62.59826965	0.951079655	0.863035774	7.579258025	21.58965751	13.79551586	165.8682454	0.913728426	14.90815695	173.5161591	0.67228397	0.423043543
1945	Chinook_1	0.924807161	0.689729067	0.63786638	118.92	122.12	129.29	5.181002282	17.04313545	10.72434158	67.20752563	0.950236261	0.799880028	8.039165817	20.33454015	12.31391048	203.023379	0.891943653	15.49829809	220.8336029	0.725533353	0.532332943
1946	Chinook_1	0.935184073	0.771101909	0.721122224	110.64	113.62	121.65	5.259769082	16.71379025	9.310554695	114.8619568	0.964967299	0.97758646	8.329153091	19.90520286	10.59236765	320.6518351	0.841193825	17.63082536	335.6883545	0.784962064	0.571880426
1947	Chinook_1	0.927380933	0.690091069	0.6399773	110.45	113.93	121.7	5.478531554	16.12173416	9.992050362	86.89625397	0.975447917	0.955011559	8.201914877	19.67619356	12.03587262	258.8485896	0.881453454	17.00418901	274.0377502	0.712865347	0.532115202
1948	Chinook_1	0.945119325	0.630634255	0.596024622	132.96	134.96	138.86	3.100323163	27.59181269	12.01188374	133.5401215	0.973454964	1.3467103	6.212298058	28.01236613	13.74781593	402.7114919	0.841107508	21.22118648	422.3431396	0.682546329	0.501276969

Columbia River System Operations Environmental Impact Statement
Appendix E: Fish, Aquatic Macroinvertebrates, and Aquatic Habitat

Year	Species	InRivSurvSNK	InRivSurvCol	InRivSurv	MedDayLGR	MedDayConfl	MedDayBON	SNKTravelTime	SNKMigRate	SNKTemp	SNKFlow	SNKFSpill	SNKGas	LCTravelTime	LCMigRate	LCTemp	LCFlow	LCFSpill	LCGas	BonFlow	monte_q975	monte_q025
1949	Chinook_1	0.941611146	0.57467434	0.541119764	126.06	128.17	134.11	3.166792646	26.95728627	12.16335049	118.1861816	0.971138489	1.203732204	6.761429861	25.21350864	14.31419945	330.6573639	0.840229799	18.30280765	355.2485352	0.647447379	0.424858619
1950	Chinook_1	0.94036978	0.687996791	0.646971392	132.28	134.4	140.46	3.772573136	22.84777049	11.26592464	89.06238098	0.978500319	1.076886272	6.988166861	24.20840262	12.89646228	267.0198491	0.874024898	17.15627495	283.9216003	0.746000954	0.524038509
1951	Chinook_1	0.940750052	0.646071863	0.607792138	130.78	132.73	139	3.752009198	23.14820785	11.39031487	105.1453979	0.962851048	1.160851383	6.658380553	25.74358342	13.61442757	341.0569051	0.828355054	18.19307852	356.8728027	0.700071326	0.507302038
1952	Chinook_1	0.948563121	0.724390861	0.687130455	125.29	127.26	133.33	3.539834403	24.41712368	10.65001907	157.7332123	0.952232862	1.073069286	7.074994273	24.33571603	12.19411977	355.3974406	0.815536181	18.17764521	369.6945496	0.766291828	0.56966498
1953	Chinook_1	0.932248763	0.670684269	0.62524458	132.34	134.84	141.54	4.667881675	18.88274721	11.04626389	82.66471863	0.963035846	1.003823853	7.136217594	23.47014072	13.06417243	255.5237986	0.868219296	16.66242027	270.4333191	0.700204153	0.530137758
1954	Chinook_1	0.942225263	0.690524188	0.650629334	139.47	141.18	145.81	3.857077681	22.60513913	11.16204472	101.815036	0.961155427	1.094530773	6.591175959	26.00215234	12.97707033	310.8389537	0.843387206	17.71063169	320.8485107	0.739217437	0.548357117
1955	Chinook_1	0.939907352	0.649376869	0.610354094	135.09	137.18	143.15	3.834919341	22.61800312	11.27868443	84.46255035	0.973273134	1.015513134	7.003823698	23.97905391	13.45767927	236.9499054	0.889005661	16.6441342	249.4746857	0.710309469	0.498224031
1956	Chinook_1	0.942830813	0.730517814	0.688754705	117.66	119.99	126.59	4.175037801	20.7840104	10.15770817	138.2622681	0.960046601	1.195939445	7.436139166	22.84295589	11.65557337	391.1296692	0.815131992	19.64155881	407.0189819	0.74529955	0.598098587
1957	Chinook_1	0.93420003	0.712891317	0.66598309	117.2	120.63	126.48	4.874808751	18.01972988	10.44516907	121.3573898	0.958111489	1.010146332	7.471507877	22.06259203	11.87573687	318.8364512	0.847169886	18.07206059	334.7771301	0.724474882	0.586036635
1958	Chinook_1	0.945098289	0.677484047	0.640289013	127.42	129.53	134.74	3.369606204	25.3395453	11.3269207	118.6450653	0.97117933	1.12254343	6.706416637	25.75250368	12.97368447	334.4650167	0.838060091	18.29690504	355.6206055	0.721605223	0.541177968
1959	Chinook_1	0.937574189	0.618540239	0.579927363	136.17	138.11	143.74	3.689203463	23.2951907	11.81298332	81.67079468	0.978894567	1.168298054	6.679508828	25.37194204	13.89189736	285.24322	0.864681234	17.72503026	295.7714539	0.680907938	0.472769548
1960	Chinook_1	0.939273595	0.643443154	0.604369164	134.4	136.23	141.46	3.949062288	21.99997941	11.22958927	87.2541687	0.973897505	1.129856777	6.921292625	24.31964034	13.52531926	263.1848272	0.874287566	17.33599822	272.0845642	0.708676601	0.488229596
1961	Chinook_1	0.919747768	0.655184248	0.60260425	118.75	121.99	128.36	5.695669383	15.6826935	10.75580101	61.61362991	0.969704497	0.983410835	7.83823806	20.7723757	12.90828292	236.7375488	0.886421273	16.64094766	246.044754	0.689868878	0.505605335
1962	Chinook_1	0.936064364	0.702404429	0.657495756	119.62	122.22	129.44	4.443298809	19.54585256	10.53264713	89.14200134	0.982349348	1.115723515	7.789803714	21.19423823	12.25125249	248.4126867	0.886856963	17.22060442	254.2181549	0.742019176	0.527336656
1963	Chinook_1	0.922118709	0.634666021	0.585237412	118.22	121.31	127.76	5.453058347	16.24292243	10.84863815	68.49351196	0.95689857	0.851952267	8.091965444	19.92364453	12.95043262	198.5020243	0.901066542	15.5339032	208.074707	0.671159652	0.489117992
1964	Chinook_1	0.942494274	0.626186666	0.590177347	133.63	135.81	142.01	3.510752045	24.59205289	11.49808865	92.38935547	0.971550941	1.038137913	6.662766531	25.67829191	13.98245637	273.5558395	0.866659204	17.07802057	288.6371155	0.714211087	0.451514877
1965	Chinook_1	0.941251681	0.531608693	0.500377576	144.43	145.95	145.77	2.765829861	30.83941682	13.28970165	135.6426117	0.95936054	1.166245174	6.334494241	27.24293899	14.3451252	328.1638082	0.822462718	17.9994429	335.7718811	0.597366596	0.418367164
1966	Chinook_1	0.91776341	0.710897239	0.652435474	111.14	115.02	123.11	6.198017053	14.27082342	10.03481083	60.78222275	0.964766836	0.850830936	8.59162011	18.60154749	11.3954277	186.8302892	0.908937355	15.27993361	197.0668335	0.716803651	0.550772086
1967	Chinook_1	0.927480631	0.721887857	0.669537006	125.08	128.22	135.24	5.019380093	17.31911221	10.62183495	56.82792053	0.961050284	0.904004383	7.594456963	21.87951701	11.98006455	224.894165	0.889247576	16.05786689	238.1805573	0.744087681	0.550486151
1968	Chinook_1	0.921347794	0.433878443	0.399752947	139.77	141.64	143.16	3.302830435	25.87403081	14.55237217	69.4795929	0.95501703	0.969315243	6.919244632	23.69058379	15.31413603	219.2219823	0.877092779	15.81810188	229.0761261	0.574595784	0.283075587
1969	Chinook_1	0.937039861	0.679561201	0.636775933	117.41	119.97	126.7	4.547307834	19.23751374	10.33544292	112.4046646	0.969492793	1.145501614	7.639783129	21.72053702	12.68086195	315.5476278	0.841802905	17.97409534	322.7494507	0.724912853	0.536266298
1970	Chinook_1	0.933650678	0.691826851	0.645924608	127.1	129.39	135.9	4.516891666	19.27573168	10.89266911	86.61368408	0.948676729	0.861142731	7.501571	22.1127754	12.47384771	224.7757111	0.874355048	15.67931422	233.5615387	0.712595866	0.547157878
1971	Chinook_1	0.950421234	0.635299045	0.603801702	138.89	140.6	144.3	2.661568828	31.93759469	12.33267479	152.385495	0.95882988	1.256460953	5.781855084	31.1080233	13.9498388	419.086085	0.786630968	19.87769381	424.659668	0.70157818	0.504828537
1972	Chinook_1	0.942491373	0.648699162	0.611393364	125.5	127.69	133.13	3.54624708	24.20599601	11.46660709	119.6628113	0.975463521	1.250487137	6.699467972	25.29543562	13.5370868	365.7953695	0.837643961	19.73050499	367.8673706	0.691404906	0.518435254
1973	Chinook_1	0.913193272	0.61408111	0.560774738	121.06	124.33	129.92	6.078401223	14.72326771	11.07201538	50.61755295	0.925488114	0.808424759	8.168217577	19.74445656	13.03069035	158.1300176	0.88098368	14.15889899	165.07901	0.637086951	0.479877248
1974	Chinook_1	0.945961269	0.603413462	0.570805765	135.51	137.44	142.07	2.917803772	29.21484027	12.35430679	135.994458	0.959305787	1.263627911	6.121632688	28.68479882	14.3066783	396.8688456	0.806306402	19.77745104	401.187439	0.67070397	0.45585484
1975	Chinook_1	0.94676303	0.609510385	0.5770619	145.26	147.18	150.99	2.866186619	29.72577534	12.36120605	125.9185928	0.968297374	1.197625542	6.140501022	28.30116526	14.07195505	326.4931183	0.831149876	18.15639861	333.5541992	0.671157847	0.48701996
1976	Chinook_1	0.94451281	0.74312619	0.701892206	121.33	123.77	130.81	3.954241969	21.83101861	10.26920013	120.8968262	0.974516821	1.160975838	7.361222409	23.04344136	11.80036942	323.5615031	0.843233585	18.17840799	334.282074	0.782579656	0.600045344
1977	Chinook_1	0.909786448	0.529277181	0.481529207	129.65	132.32	137.5	5.047585279	17.38200224	12.73987713	37.89460449	0.933469534	0.80447979	7.985307954	20.08758073	14.26131884	138.8086065	0.90008078	13.67112811	144.9246216	0.592638734	0.363757509
1978	Chinook_1	0.923525729	0.747897091	0.690702206	109.73	113.34	121.59	6.247914135	14.36029351	9.533019066	87.91951752	0.969607198	0.940094376	8.417582348	19.16923826	11.06944895	243.0313288	0.87990578	16.7283872	256.3052368	0.756154021	0.564197621
1979	Chinook_1	0.916696722	0.746069712	0.683919659	112.4	115.78	124.12	6.556150682	13.72775406	9.737675476	61.28513336	0.945919383	0.732594442	8.617976129	18.82313951	11.0458498	200.5341899	0.888174961	15.30992802	223.416626	0.753047969	0.538413724
1980	Chinook_1	0.94623682	0.642519129	0.607975257	136.29	138.34	144.08	3.151192054	27.12809575	11.69546432	110.1160034	0.959941113	1.145692348	6.437539287	26.9974705	13.81822348	330.3928019	0.83071511	18.0730621	336.8589783	0.699804957	0.510350432
1981	Chinook_1	0.916968267	0.55128142	0.505507568	128.43	130.94	130.37	5.086183272	17.48265757	12.68612442	78.56468964	0.946115041	0.917032146	7.46695824	21.72565671	13.92365456	233.9461085	0.867104063	15.89580504	243.1517181	0.614237855	0.40212988
1982	Chinook_1	0.942309848	0.547253599	0.515682456	142.91	144.55	146.01	2.856555156	29.84335955	13.15684605	125.3093582	0.968404937	1.232223797	6.099171758	28.41383437	14.73233239	351.9441427	0.823171328	18.77408663	356.706543	0.654313961	0.402114933
1983	Chinook_1	0.934794136	0.640977757	0.599182248	123.11	125.5	130.4	4.240389757	20.52435274	11.36320229	101.2793457	0.969927776	1.057750702	7.302077278	22.68159313	13.23401642	278.8687744	0.858584056	17.22675276	286.9714355	0.669317688	0.512554673
1984	Chinook_1	0.94400516	0.611266742	0.577038959	129.19	131.42	136.5	3.102400057	27.42957441	12.14361057	123.344											

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Year	Species	InRivSurvSNK	InRivSurvLCol	InRivSurv	MedDayLGR	MedDayConfl	MedDayBON	SNKTravelTime	SNKMigRate	SNKTemp	SNKFlow	SNKFSpill	SNKGas	LCTravelTime	LCMigRate	LCTemp	LCFlow	LCFSpill	LCGas	BonFlow	monte_q975	monte_q025
1987	Chinook_1	0.916999568	0.558061895	0.511742517	117.95	120.58	126.56	4.629806578	18.81898763	12.31899204	57.82825012	0.972962296	1.033363342	7.704874985	21.12582988	13.7583677	250.3982417	0.880652914	16.8565189	264.8221741	0.615427684	0.405420252
1988	Chinook_1	0.907851691	0.734673837	0.666974885	109.15	112.86	121.19	7.910552666	11.72246198	9.335994148	59.47561111	0.953155231	0.779426765	8.818678841	18.08733034	10.89493942	183.342308	0.910386682	15.20033487	190.3459778	0.72821502	0.543624293
1989	Chinook_1	0.940908683	0.569677379	0.536014393	141.85	143.9	148.51	3.409482844	24.97608008	11.81730518	78.12469025	0.982060456	1.162176704	6.814088196	24.73973231	14.29627609	242.4506811	0.893027226	17.32799371	246.5485077	0.668755265	0.40903777
1990	Chinook_1	0.923189594	0.435609729	0.402150369	131.6	133.82	138.24	3.431225017	24.8303309	13.88313637	62.96385422	0.979002941	1.137556171	7.10595274	22.97903123	15.33722814	212.4357808	0.908875664	16.71885204	211.2241821	0.590973204	0.275269244
1991	Chinook_1	0.92111316	0.641417595	0.590818188	123.59	126.65	131.76	5.417795964	16.39552016	11.0617485	60.4889595	0.965980363	1.000993538	7.508171231	21.89041704	13.11829869	250.6120046	0.877359817	16.7591478	252.1783447	0.676031145	0.504924243
1992	Chinook_1	0.910810052	0.546076249	0.497371737	121.11	123.73	128.33	4.775075763	18.23057276	12.79803829	49.30284119	0.960463846	0.874329376	7.924595751	20.20892302	13.72724899	192.4604289	0.906869034	15.59798845	198.3365326	0.592840117	0.406568109
1993	Chinook_1	0.933821883	0.729584783	0.681302236	120.74	123.53	131.05	4.602341816	18.79821446	10.44984303	78.15470886	0.951518726	0.757965136	7.924098767	20.89588734	11.63792626	221.8816961	0.889297575	15.80519867	240.2672272	0.763356593	0.558999401
1994	Chinook_1	0.924724046	0.479909104	0.443783488	128.68	130.92	136.18	3.671446666	23.33482813	12.9633976	60.64072266	0.976173246	1.078376007	7.224264994	22.74149917	14.63220263	213.3206762	0.906580091	16.6626579	221.3425751	0.567297063	0.346396058
1995	Chinook_1	0.931189519	0.649613199	0.604913002	127.36	129.61	135.21	4.729979694	18.64473668	11.09065399	92.08553772	0.959877551	0.969075108	7.436397344	22.11887845	13.0687232	240.9718882	0.874117325	16.31101433	250.9286652	0.677863385	0.520884012
1996	Chinook_1	0.936483339	0.536556902	0.502476599	140.7	142.07	143.9	2.894296721	29.45435112	13.74603443	122.2700714	0.958481181	1.168589115	6.343264647	27.05190433	14.66326014	331.6008403	0.824040045	18.04080296	342.4441833	0.632749284	0.404299767
1997	Chinook_1	0.946430549	0.566202454	0.535871299	134.64	136.19	138.76	2.685642488	31.7096264	12.71912651	161.8798187	0.961773491	1.42484169	5.846291997	30.33602254	14.50329383	462.8523	0.801067054	22.30143468	471.9979858	0.649493542	0.431130159
1998	Chinook_1	0.926089561	0.674060213	0.624240126	116.01	118.99	125.79	5.388713598	16.47037562	10.52623863	89.67572021	0.954813766	0.901768494	7.788991205	21.14025883	12.71329308	281.4712499	0.854088823	16.76849063	300.2525635	0.718533039	0.532163184
1999	Chinook_1	0.933498789	0.644595396	0.601729022	121.06	123.27	129.54	4.460633345	19.59851642	10.97312603	99.10372162	0.972421694	1.083430195	7.731935576	21.20799847	13.11705494	269.2231191	0.872255584	17.36833064	273.2650757	0.704899032	0.494131822
2000	Chinook_1	0.934128531	0.492768224	0.460308857	131.06	133.15	136.31	3.307569943	25.86380102	12.75286827	87.11137543	0.982615006	1.214183807	6.992782906	23.6628869	14.55346775	248.8222631	0.888805687	17.53608322	256.7334595	0.582181795	0.365186945
2001	Chinook_1	0.901998114	0.67206265	0.606199243	110.85	115.27	123.45	7.732205547	11.81471181	9.812289238	40.84489517	0.90403831	0.642381001	8.965012729	17.79765763	12.16131115	138.6550992	0.887004584	13.33443483	150.5421448	0.696145273	0.497621998
2002	Chinook_1	0.930664983	0.692929399	0.644885127	119.9	122.82	129.67	4.828399539	18.02926746	10.54598541	70.11482849	0.979590333	1.07222271	7.813864246	20.95505902	12.28302606	234.8389867	0.897038917	17.06477912	242.4254303	0.719674477	0.543354184
2003	Chinook_1	0.933996581	0.626327312	0.584987568	130.58	133.05	140.06	4.058642268	21.32613473	11.54360847	76.90997314	0.97288202	1.04174099	7.188043348	23.06658436	13.57679001	240.7525558	0.88894245	16.90704155	260.4354248	0.67832258	0.480427483
2004	Chinook_1	0.911677585	0.722304189	0.658508539	107.4	111.8	120.13	7.491854139	12.13189929	9.239259338	60.71099243	0.961347878	0.831694698	8.730858922	18.23702933	11.31112766	202.0129801	0.901996771	15.75253987	219.833252	0.726250121	0.547512194
2005	Chinook_1	0.920659327	0.57965492	0.533664709	122.67	125.34	131.02	4.737477459	18.55627983	12.15538731	67.1325058	0.966418314	0.95613308	7.713847525	20.96974997	13.88730796	206.5040741	0.901550005	15.9283212	216.1983643	0.655532076	0.435535704
2006	Chinook_1	0.944676789	0.728140899	0.687857806	121.51	123.64	130.8	3.853836223	22.4557847	10.42948494	127.8444931	0.971383309	1.132489204	7.556248277	22.15573469	11.94847743	291.8438721	0.861277779	17.78990555	297.8026123	0.779831681	0.558928451
2007	Chinook_1	0.920351544	0.606394036	0.558095687	120.87	123.23	129.44	4.957941048	17.81328382	11.89204922	68.44199371	0.977652192	1.094354916	7.633205943	21.27814302	13.61476469	243.7468211	0.889269928	17.13241227	253.0018616	0.65905552	0.452165632
2008	Chinook_1	0.902274752	0.733048509	0.661411162	107.41	112.13	120.28	8.151316971	11.1369262	9.57006855	60.82829208	0.919988394	0.678269243	8.810917564	18.10950351	11.03706344	180.9872665	0.886600057	14.23927522	192.7246399	0.723946129	0.558159279

11 Table 4-10. Snake River Steelhead_MO3_Wildfish_Raw_Data

Year	Species	InRivSurvSNK	InRivSurvLCol	InRivSurv	MedDayLGR	MedDayConfl	MedDayBON	SNKTravelTime	SNKMigRate	SNKTemp	SNKFlow	SNKFSpill	SNKGas	LCTravelTime	LCMigRate	LCTemp	LCFlow	LCFSpill	LCGas	BonFlow	monte_q975	monte_q025
SCN MO3-Steelhead-SAL-HW																						
1929	Steelhead	0.896404826	0.57219035	0.512914191	128.47	130.27	137.12	4.393150523	19.64609822	11.05545006	63.82778244	0.982632887	0.793209839	8.328929938	20.77013038	12.70908244	165.2178116	0.946995318	14.46935479	176.1290894	0.635994963	0.395027466
1930	Steelhead	0.754506966	0.446434311	0.336837797	140.16	140.21	143.9	3.86003042	22.08241311	13.21075382	62.70593262	0.985576141	0.905415058	7.678334981	22.01112095	15.08399041	159.0707677	0.951663693	14.5319651	164.8411407	0.502351442	0.240046535
1931	Steelhead	0.819409272	0.458975423	0.376088718	138.02	139.24	144.36	3.587064728	23.73527577	12.62741623	58.86043243	0.990219724	0.958304501	7.43275062	22.60556987	15.13726981	161.9846242	0.957180421	14.92655834	167.0583496	0.536485475	0.250273738
1932	Steelhead	0.91996341	0.649212346	0.597251603	121.13	123.49	129.16	4.242455661	20.46083254	10.53812847	99.57953033	0.988763583	1.09147625	6.5642519	27.65612496	12.20318778	292.7756602	0.910047382	17.64748637	304.4317932	0.717040501	0.464734673
1933	Steelhead	0.891480232	0.585149624	0.521649323	127.65	129.55	135.13	4.456168808	19.43170886	11.33985081	68.18749084	0.989073682	1.023069382	7.004742913	25.46742892	13.36325423	247.8490067	0.931248983	16.95366081	263.3229675	0.638590025	0.41803955
1934	Steelhead	0.708992631	0.487274981	0.345474371	138.63	138.2	139.61	3.76440233	22.63763276	14.37220631	59.37915726	0.986854625	1.198201275	5.974547252	29.33341021	15.45164076	285.1780446	0.905493965	17.56161229	290.4157715	0.502606531	0.252600751
1935	Steelhead	0.892439992	0.568780313	0.507602298	125.94	127.93	134.38	4.002016	21.47374829	11.40548744	67.98436737	0.993132329	1.019650269	7.16366668	24.52938334	13.51748625	221.4864477	0.944690824	16.59884659	232.6940002	0.632765953	0.379483616

Columbia River System Operations Environmental Impact Statement
Appendix E: Fish, Aquatic Macroinvertebrates, and Aquatic Habitat

Year	Species	InRivSurvSNK	InRivSurvLCol	InRivSurv	MedDayLGR	MedDayConfl	MedDayBON	SNKTravelTime	SNKMigRate	SNKTemp	SNKFlow	SNKFSpill	SNKGas	LCTravelTime	LCMigRate	LCTemp	LCFlow	LCFSpill	LCGas	BonFlow	monte_q975	monte_q025
1936	Steelhead	0.850459035	0.615519331	0.523473976	122.36	122.51	126.33	4.524609543	19.16133342	11.11823978	115.172731	0.978297222	1.08417511	6.847507112	26.79613432	12.33980719	285.7381541	0.89881588	17.2086331	297.7406616	0.614812654	0.416851566
1937	Steelhead	0.909755063	0.583936217	0.53123893	119.71	122.47	130.25	5.189643942	16.7677542	10.47388992	50.86909637	0.975555384	0.73988719	8.805743955	20.0964587	12.27655935	163.9306361	0.941904436	14.36937634	177.5213165	0.656662977	0.395091012
1938	Steelhead	0.913491572	0.630050305	0.575545644	123.24	124.98	129.12	4.058421768	21.31636419	10.93256416	111.5926208	0.980600774	1.078533363	6.265449606	28.88492154	12.6768961	309.0633392	0.897590826	17.66275565	321.1536865	0.690139304	0.448150204
1939	Steelhead	0.802366318	0.541705575	0.434646307	136.79	137.22	140.63	3.784023359	22.54554946	12.28020897	77.29988403	0.990398324	1.119676781	7.0004149	24.85591609	13.55895726	217.2592646	0.941746821	16.69557858	222.8695526	0.55901917	0.33225473
1940	Steelhead	0.82349798	0.546992593	0.450447295	128	127.86	130.79	4.235048972	20.33053601	11.9209219	83.53600616	0.988514972	1.053679466	7.144379333	24.67277149	13.68392642	225.1434631	0.937396894	16.70084667	232.7225494	0.554697113	0.345230135
1941	Steelhead	0.832127208	0.504266707	0.419614047	129.36	130.73	135.77	3.899196826	21.98794612	13.08317108	55.46320648	0.991073382	0.87036314	7.520124942	22.83302499	14.51827113	181.8326035	0.954566091	15.45406675	189.7847443	0.551939979	0.288343674
1942	Steelhead	0.917552221	0.628229877	0.576433719	120.49	122.66	128.8	4.779930487	18.22255614	10.32886944	83.53708801	0.987992167	0.931820011	7.64486187	23.29221131	11.92450428	215.9066315	0.943158627	16.20077324	224.6229248	0.685450254	0.443419254
1943	Steelhead	0.920615211	0.614598601	0.565808821	127.41	129.18	133.97	3.660147779	23.40638228	10.95284805	113.5797653	0.986106718	1.110214424	6.38473323	27.8385642	12.94294373	284.1959178	0.910037011	17.47139057	293.8853149	0.687115113	0.426675698
1944	Steelhead	0.903470054	0.542602786	0.490225368	121.5	123.8	131.1	4.845276706	17.91073999	10.64998608	51.74303818	0.979177606	0.768539858	8.816180743	19.54381663	12.97972536	143.5545247	0.949272662	13.87258673	151.6450348	0.619918796	0.347872411
1945	Steelhead	0.89414054	0.577464351	0.516334286	130.17	131.62	136.48	3.835825458	22.43425551	11.48583412	82.97876587	0.98991282	0.945573616	7.2543758	24.3381576	13.37719472	223.1079356	0.937719891	16.2422967	237.8478851	0.638278256	0.393691244
1946	Steelhead	0.922775542	0.656694446	0.605981574	123.41	125.26	129.45	4.164284848	20.83603337	10.51072006	111.1220093	0.978738654	1.084479046	6.11627008	30.02581722	12.14476029	333.7866007	0.88352409	17.95499404	346.4668579	0.729689476	0.469275654
1947	Steelhead	0.797575669	0.541477883	0.431869584	134.55	134.31	137.01	3.663355961	23.34518438	12.81149673	113.1097534	0.976684475	1.142481327	6.093876682	29.28562637	14.53567791	304.3712311	0.887621462	17.51115513	312.6004944	0.553927564	0.317657177
1948	Steelhead	0.903118334	0.631508482	0.570326888	134.03	135.54	140.69	3.209396958	26.63107371	11.7688179	145.9042328	0.981186414	1.365327549	5.400612846	33.96383038	13.74026092	426.7423147	0.869012952	22.2957557	447.7825623	0.681039441	0.438819051
1949	Steelhead	0.917591166	0.634941196	0.582616433	121.81	123.51	128.26	4.032340311	21.49701404	10.71792965	126.4264862	0.981630754	1.116067791	6.16496218	29.67362489	12.67351087	331.7122192	0.886970262	18.09997145	347.686554	0.697088265	0.469823995
1950	Steelhead	0.912985126	0.635848622	0.580520334	124.46	126.38	132.84	4.443659849	19.464192	10.67598476	91.72471313	0.987944984	1.039714432	7.047333196	25.44040628	12.09106127	255.8590088	0.923167417	16.98757807	269.9475403	0.702310099	0.450698362
1951	Steelhead	0.907930829	0.616968696	0.560164899	122.66	124.58	129.85	4.211160481	20.53115501	11.02642021	101.0824066	0.984333587	1.128641605	6.20365715	29.27401681	13.07548253	315.8403269	0.89308845	17.80695756	329.6502686	0.676759742	0.438115394
1952	Steelhead	0.930403833	0.665599477	0.619276304	124.93	126.49	131.21	3.523328915	24.39091469	10.622118	157.7349426	0.971730149	1.086239433	5.840829216	31.48488805	12.13607788	357.28125	0.867849191	18.16727495	369.9491882	0.732174399	0.482229524
1953	Steelhead	0.91486358	0.605341868	0.553805229	127.19	129.18	136.26	3.912724376	22.08310465	11.01538754	88.15855408	0.988940966	0.969183064	6.837144502	26.24403497	13.15240224	261.2819468	0.923655113	16.92334445	278.2255554	0.665670714	0.438956999
1954	Steelhead	0.920909794	0.661644135	0.609314564	117.12	119.93	126.32	5.48339463	16.06096309	9.953236961	88.78773804	0.979803216	0.964610481	7.297733769	24.99782339	11.35567649	263.4781723	0.917634259	16.85397768	276.7589722	0.723441781	0.469584186
1955	Steelhead	0.921401486	0.602808879	0.555428997	124.58	126.71	133.4	4.100961283	21.03157386	10.66366043	75.5759552	0.991218686	0.91504631	7.644723326	23.15299778	12.63486481	210.1589533	0.945569684	16.02073574	224.2655182	0.666780732	0.418928344
1956	Steelhead	0.923707759	0.665863282	0.615063081	129.3	130.96	135.47	3.705699094	23.23676113	10.84546814	140.7667145	0.975665498	1.260844994	5.468505844	33.69276815	12.50887648	406.4331207	0.861614853	20.13580306	425.0817261	0.718689536	0.482012951
1957	Steelhead	0.912058643	0.655641868	0.597983833	123.68	125.44	130.57	4.441955186	19.57622505	10.6985424	129.0360443	0.974527824	1.077175713	6.391599946	28.72532428	12.24531603	343.9087067	0.885906845	18.62470357	359.8193359	0.692491335	0.464518845
1958	Steelhead	0.914431104	0.634604223	0.58030184	128.65	130.25	135.07	3.725073703	23.05621371	11.13103008	121.8859909	0.980503166	1.110761166	6.24333062	29.38095123	12.81690645	329.7268728	0.887094229	18.15130695	346.9906006	0.683843497	0.465045155
1959	Steelhead	0.89208689	0.613460243	0.54725984	119.53	121.69	126.24	5.627502717	15.54205756	10.72065678	74.9362381	0.975803876	1.015288353	7.13815093	25.50587703	12.56462987	263.1998316	0.909591645	16.87416252	274.5951538	0.665244553	0.439899415
1960	Steelhead	0.922308219	0.638167018	0.588586686	120.6	122.97	129.39	4.520997494	19.15787331	10.28928757	78.78773651	0.992888153	1.079260635	7.179466464	24.88390571	12.01974773	244.9225006	0.934343924	17.10478131	255.4190216	0.716399578	0.431868076
1961	Steelhead	0.902179407	0.60371928	0.544663102	123.79	125.95	132.53	4.385648131	19.70446374	11.00650787	69.32971191	0.987746227	1.029169464	6.825082563	26.32627311	13.10548846	271.1297379	0.920370559	17.31652832	282.6332703	0.662015289	0.421937837
1962	Steelhead	0.914574859	0.59429912	0.543531033	129.55	131.39	136.98	3.489296585	24.46415093	11.24126205	88.10972443	0.994562316	1.155988216	6.594088994	26.88694682	13.44529915	255.4711482	0.929607123	17.3652571	261.3048706	0.682464363	0.396034598
1963	Steelhead	0.892552256	0.565790702	0.504997768	133.49	135.4	142.46	3.54872144	24.1229229	11.79104404	88.84111328	0.989487457	0.971642017	6.773732163	26.08661714	13.88234043	244.9379476	0.926648239	16.53789616	257.5479431	0.638980145	0.367248218
1964	Steelhead	0.910044643	0.590657588	0.537524774	131.58	133.47	139.4	3.701803245	23.1592305	11.25650406	93.43356323	0.98772887	1.001938248	6.942563869	25.48777044	13.37106673	251.6714223	0.922464301	16.61736727	263.9472656	0.663831449	0.412042734
1965	Steelhead	0.913610686	0.630493035	0.576025174	131.74	133.53	138.43	4.191693738	20.67736427	11.00301476	126.7678345	0.97758975	1.075537586	6.155276738	29.63252103	12.82973512	322.467687	0.882045647	17.689768	332.0551147	0.680446272	0.462168687
1966	Steelhead	0.882724024	0.57459971	0.507212968	130.04	131.7	137.16	3.621065386	23.54895478	11.65660858	68.36349335	0.994591486	1.049771309	7.033034168	24.80028466	13.42401044	219.2739003	0.94637388	16.63656537	226.5662384	0.658326665	0.361696335
1967	Steelhead	0.891776763	0.619869732	0.552785423	133.7	135.23	140.8	4.346973307	19.85887816	11.26246243	88.02864838	0.977092147	1.000310135	6.910654821	25.83280788	12.71362289	280.2549947	0.902856876	16.9868083	289.3380432	0.665178631	0.438761601
1968	Steelhead	0.833762784	0.538012412	0.448574726	120.06	121.04	126.31	6.023260608	14.49283743	11.95480881	60.48068314	0.949843776	0.730220032	8.685131043	20.06627703	13.15001059	180.5535177	0.904026449	13.75874488	188.7473755	0.567501239	0.348369581
1969	Steelhead	0.911440591	0.608828437	0.55491095	133.28	134.98	140.07	3.040269211	28.01316254	11.6565588	130.6308746	0.976312828	1.213567162	5.435539432	33.39408176	13.97409185	371.5631866	0.866227289	18.85858011	378.5861206	0.693738183	0.420336623
1970	Steelhead	0.916631182	0.615224101	0.563933595	124.14	126.61	134.23	4.484038122	19.35404671	10.59582996	84.63358154	0.981658483	0.838075256	7.778035529	22.75969266	12.27600447	223.7584712	0.923213452	15.51108917	233.4108124	0.67916912	0.43482883
1971	Steelhead	0.89302811	0.631374077	0.563834799	139.89	141.17	145.18	3.31407994	25.79185861	11.97907238	146.3385956	0.970946169	1.223018837	5.224903345	34.96538724	13.57395347	406.21					

Columbia River System Operations Environmental Impact Statement
Appendix E: Fish, Aquatic Macroinvertebrates, and Aquatic Habitat

Year	Species	InRivSurvSNK	InRivSurvLCol	InRivSurv	MedDayLGR	MedDayConfl	MedDayBON	SNKTravelTime	SNKMigRate	SNKTemp	SNKFlow	SNKFSpill	SNKGas	LCTravelTime	LCMigRate	LCTemp	LCFlow	LCFSpill	LCGas	BonFlow	monte_q975	monte_q025
1973	Steelhead	0.884094208	0.550659624	0.486834984	117.72	120.58	129.09	5.420190036	16.08074657	10.77659855	50.5571907	0.970337832	0.782455254	8.780433103	19.67366429	12.92595021	155.2285716	0.934637219	14.05164997	161.3557739	0.606970037	0.369026977
1974	Steelhead	0.899441774	0.625077685	0.562220982	134.42	135.93	140.43	3.663339466	23.43826014	11.63127136	126.604895	0.97342732	1.203693771	5.41818957	33.46835929	13.51336686	380.5458934	0.86195448	19.20689106	386.7110291	0.675611635	0.434314725
1975	Steelhead	0.923859465	0.648018005	0.598677567	116.08	118.91	125.67	5.084749795	17.24105092	9.985352707	83.58813782	0.9897874	0.907075596	7.656961821	23.68241752	11.55098232	235.9888535	0.937657426	16.5305961	247.2622681	0.719684797	0.457385912
1976	Steelhead	0.927083727	0.668911762	0.620137209	124.16	125.96	131.04	4.339301363	20.02067125	10.3811409	131.3689972	0.975753379	1.117785358	6.230949216	29.3560437	11.90744702	328.9560852	0.882868926	17.99498018	333.1289978	0.724328737	0.498617897
1977	Steelhead	0.854830545	0.507916062	0.434182164	121.4	123.31	130.15	5.134325884	16.92021407	11.73026485	36.76270905	0.971774149	0.759212065	8.925983585	19.11760693	13.56092087	134.0347252	0.943731358	13.44835385	141.4520569	0.562492852	0.315867929
1978	Steelhead	0.896432857	0.604916457	0.542266987	135.22	136.82	141.78	3.572484337	23.95701216	11.62664471	94.80915222	0.992163098	1.138587379	6.384977207	27.45971185	13.284434	264.6935883	0.924999595	17.45861832	273.6483154	0.66325162	0.40498694
1979	Steelhead	0.914074822	0.628674519	0.574655549	122.38	124.56	130.71	4.639955707	18.70907814	10.59845524	79.38390961	0.984645069	0.919882011	7.518155225	24.01438388	12.09575748	232.9874395	0.930137356	16.23743725	247.1830444	0.711156709	0.449857714
1980	Steelhead	0.915560722	0.64622455	0.591657815	117.37	119.98	124.99	5.150686406	17.09334119	10.20369568	87.52772064	0.976709783	0.924421883	7.029357277	26.49639245	12.01251539	287.3805974	0.902963152	16.91244427	306.3229675	0.69153917	0.462253495
1981	Steelhead	0.813910324	0.526165034	0.428251153	138.32	139.03	143.97	3.643664837	23.52584149	13.57654171	89.95480957	0.97933166	0.988533783	6.491647698	26.99447945	14.90098111	264.7968216	0.91081051	16.69239219	273.5896606	0.552763216	0.308463138
1982	Steelhead	0.89943063	0.616141411	0.554176457	128.49	130.06	135.33	4.399626836	19.67876374	11.18741302	110.3999908	0.97991153	1.117410278	6.333283961	28.78731367	13.02074289	314.4502411	0.890233765	17.85340754	322.8909607	0.661396827	0.438200375
1983	Steelhead	0.909481507	0.620331505	0.564180032	127.95	129.68	134.55	4.556219198	19.11260473	10.90520668	102.5412827	0.982633114	1.036968708	6.596256636	27.50247394	12.86991978	290.219752	0.904457996	17.31657489	301.9002991	0.662619152	0.444448087
1984	Steelhead	0.917008205	0.626049254	0.574092302	126.31	128.16	133.36	4.227654658	20.47733254	10.76446934	123.5200653	0.985661614	1.047274971	6.830230214	26.49914548	12.43791199	266.8156153	0.914784978	17.07453903	275.0581055	0.688786915	0.45148162
1985	Steelhead	0.922143076	0.634497566	0.585097537	122.99	124.9	131.05	4.212798946	20.49175795	10.4731781	95.66685638	0.993110919	1.034306049	7.230438568	24.6442372	12.02175824	235.3912811	0.939843973	16.97562011	242.7809753	0.709160187	0.461108762
1986	Steelhead	0.902688245	0.594979116	0.537080654	128.25	129.89	134.55	4.393635534	19.71052003	11.12368107	106.907579	0.988083303	1.054391479	6.722778492	26.497897	13.2116313	263.4075368	0.918498337	17.1319046	268.0259705	0.645456471	0.431588746
1987	Steelhead	0.746476783	0.506059933	0.377761991	129.38	128.85	131.3	4.569509588	18.76929503	13.29232025	53.87142487	0.980275393	1.024452209	7.223487042	24.49196435	14.34355847	228.9732768	0.923014661	16.22441196	235.3372498	0.504362548	0.276041043
1988	Steelhead	0.902621686	0.579881895	0.523413974	131.7	133.72	139.36	3.902253382	21.89821221	11.27122421	62.38008804	0.99237119	0.945582294	7.460412778	23.21123038	13.06718365	190.0762431	0.955778013	15.8938454	195.8269806	0.649266146	0.389531616
1989	Steelhead	0.926397269	0.6650208	0.616073453	115.62	118.23	124.41	4.655301481	18.70846247	10.01159401	98.01724091	0.993217671	1.056023026	6.976107083	26.29237139	11.40716076	273.5014165	0.920243482	17.33704662	281.1698608	0.729673791	0.466829841
1990	Steelhead	0.745597087	0.474864484	0.354057576	136.93	136.62	138.52	3.96621979	21.54801205	13.97490025	67.22151794	0.984207523	1.066629696	6.733239718	25.93604192	15.26287778	238.7786382	0.924222618	16.64313968	244.7165985	0.502565578	0.257815648
1991	Steelhead	0.877002869	0.597313044	0.523845254	122.91	124.29	128.8	5.363547124	16.28073083	11.08968525	65.26640167	0.97376889	0.961120796	7.12695536	25.38820966	12.9226621	256.1004512	0.910779456	16.57790073	256.1395264	0.622701801	0.418842909
1992	Steelhead	0.77424172	0.490696872	0.37991799	130.56	131.26	135.29	4.13420777	20.70583975	13.44504623	50.56856384	0.985313332	0.95418129	7.432457373	23.37077823	14.62282928	195.4266052	0.944981923	15.84318209	197.9950409	0.505057022	0.283503405
1993	Steelhead	0.920211266	0.633943738	0.58336217	125.22	127.24	134.07	4.2174256	20.55351174	10.50654125	98.73529968	0.981555343	0.870842648	7.389689006	24.41386211	11.98845784	253.91996	0.916448762	16.25932868	264.7316895	0.698906455	0.444052405
1994	Steelhead	0.827803541	0.531643004	0.440095961	127.31	128.07	131.98	4.7330103	18.21650736	11.68439541	60.06785583	0.983887458	0.9752985	7.769652776	22.62711231	13.56304995	194.1081619	0.944515824	15.84584697	200.0101624	0.559372941	0.335729916
1995	Steelhead	0.908746887	0.592635337	0.538555518	121.8	123.93	130.47	4.426675737	19.62098932	10.81963711	87.48014526	0.989782321	0.947387218	7.407452643	23.97555011	12.96274233	228.0972239	0.93589897	16.22116502	239.1461639	0.653703473	0.405524276
1996	Steelhead	0.877078161	0.616550471	0.540762953	129.45	130.63	133.75	4.436069004	19.56990464	11.83000622	121.2668213	0.973672843	1.074608707	6.026314557	30.05009111	13.01077096	330.6763814	0.879690925	17.81742827	343.4128113	0.642904358	0.440931688
1997	Steelhead	0.912725992	0.643923376	0.587725602	135.72	137.14	140.92	3.386271462	25.34920596	11.54818172	168.031073	0.970996034	1.42218523	4.844352908	37.99200177	13.65971041	468.9469503	0.841754397	22.44833422	475.1591492	0.692605785	0.46719943
1998	Steelhead	0.906900917	0.602587508	0.546487163	129.15	130.78	135.79	3.337499209	25.65949105	11.59333324	121.8556549	0.979257667	1.062734127	6.006689675	30.23161477	13.7414314	324.8388163	0.886165162	17.73034509	336.7099609	0.687306628	0.41846539
1999	Steelhead	0.893815669	0.595030232	0.531847345	134.06	135.92	142.04	3.757216603	22.89420596	11.72446156	105.5274368	0.98576175	1.089112186	6.143010169	29.10077516	13.64578549	302.4578044	0.902340849	17.69154565	315.5550842	0.664015013	0.412017188
2000	Steelhead	0.824931131	0.557161531	0.459619892	130.36	130.8	134.16	4.224003628	20.3734445	12.00434418	87.68536072	0.984187686	1.138268375	6.684954569	26.50044161	13.60553296	256.4916178	0.919210911	17.12368774	265.757782	0.577725442	0.359450427
2001	Steelhead	0.887249814	0.523773786	0.464718194	130.47	132.4	138.82	4.152715206	20.73571502	11.52562504	57.93331604	0.985485792	0.843837357	7.896692567	21.62671677	13.89762529	163.7508443	0.952697535	14.73141964	172.219162	0.597719821	0.353800444
2002	Steelhead	0.910358766	0.616942096	0.561638646	124.63	126.59	131.4	4.436862983	19.50474867	10.76114769	76.34583435	0.988982272	1.076717091	6.938207559	25.62714146	12.57362286	253.9883092	0.92872416	17.23500061	264.1842346	0.670026908	0.442031061
2003	Steelhead	0.904135963	0.588270552	0.531876562	126.39	128.41	134.65	4.038047165	21.3457172	11.20576553	79.72070923	0.990386903	1.011466408	6.964268513	25.33419635	13.27935632	243.8407974	0.934437195	16.92016856	262.9431763	0.657872429	0.413764427
2004	Steelhead	0.897717118	0.560253103	0.502948801	131.04	132.94	138.95	3.646626271	23.49613398	11.65357285	76.13249359	0.995143247	1.055051708	6.862370744	25.30407886	13.95194117	226.0559362	0.944763601	16.80724573	247.2705688	0.647893563	0.382017541
2005	Steelhead	0.847636736	0.52316738	0.443455891	130.84	132.07	137.09	3.679081395	23.34269015	12.91405163	79.7695343	0.992021084	1.001525784	6.988527745	24.75461613	14.57389657	217.2708486	0.942850262	16.31297414	224.1720581	0.607037163	0.320992881
2006	Steelhead	0.919592042	0.661156729	0.607994466	123.39	125.04	129.75	4.640461057	18.8351272	10.41577911	131.9135956	0.977856886	1.103369999	6.311378852	29.06700254	11.98360809	327.2440948	0.888694108	18.05902004	338.9646301	0.711538666	0.483634659
2007	Steelhead	0.856724783	0.565605943	0.484568629	119.84	121.62	126.88	4.516054206	19.25804403	11.9668602	62.26437759	0.993400764	1.07820425	6.971380718	25.22022076	13.69916789	236.2321192	0.940188219	17.0453976	244.1781616	0.600561271	0.363532554
2008	Steelhead	0.893723276	0.598397532	0.534801802	130.37	131.68	137.64	3.928961128	21.99711958	11.46669712	104.263472	0.980663323	0.972412586	6.90284624	25.67813058	13.25769726						

12 **Table 4-11. Snake River MO3 Steelhead Wildfish SAL HW Raw Data HW**

Year	Species	InRivSurvSNK	InRivSurvLCol	InRivSurv	MedDayLGR	MedDayConfl	MedDayBON	SNKTravelTime	SNKMigRate	SNKTemp	SNKFlow	SNKFSpill	SNKGas	LCTravelTime	LCMigRate	LCTemp	LCFlow	LCFSpill	LCGas	BonFlow	monte_q975	monte_q025
SCN MO3-Steelhead-SAL-HW																						
1929	Steelhead	0.896404826	0.57219035	0.512914191	128.47	130.27	137.12	4.393150523	19.64609822	11.05545006	63.82778244	0.982632887	0.793209839	8.328929938	20.77013038	12.70908244	165.2178116	0.946995318	14.46935479	176.1290894	0.635994963	0.395027466
1930	Steelhead	0.754506966	0.446434311	0.336837797	140.16	140.21	143.9	3.86003042	22.08241311	13.21075382	62.70593262	0.985576141	0.905415058	7.678334981	22.01112095	15.08399041	159.0707677	0.951663693	14.5319651	164.8411407	0.502351442	0.240046535
1931	Steelhead	0.819409272	0.458975423	0.376088718	138.02	139.24	144.36	3.587064728	23.73527577	12.62741623	58.86043243	0.990219724	0.958304501	7.43275062	22.60556987	15.13726981	161.9846242	0.957180421	14.92655834	167.0583496	0.536485475	0.250273738
1932	Steelhead	0.91996341	0.649212346	0.597251603	121.13	123.49	129.16	4.242455661	20.46083254	10.53812847	99.57953033	0.988763583	1.09147625	6.5642519	27.65612496	12.20318778	292.7756602	0.910047382	17.64748637	304.4317932	0.717040501	0.464734673
1933	Steelhead	0.891480232	0.585149624	0.521649323	127.65	129.55	135.13	4.456168808	19.43170886	11.33985081	68.18749084	0.989073682	1.023069382	7.004742913	25.46742892	13.36325423	247.8490067	0.931248983	16.95366081	263.3229675	0.638590025	0.41803955
1934	Steelhead	0.708992631	0.487274981	0.345474371	138.63	138.2	139.61	3.76440233	22.63763276	14.37220631	59.37915726	0.986854625	1.198201275	5.974547252	29.33341021	15.45164076	285.1780446	0.905493965	17.56161229	290.4157715	0.502606531	0.252600751
1935	Steelhead	0.892439992	0.568780313	0.507602298	125.94	127.93	134.38	4.002016	21.47374829	11.40548744	67.98436737	0.993132329	1.019650269	7.16366668	24.52938334	13.51748625	221.4864477	0.944690824	16.59884659	232.6940002	0.632765953	0.379483616
1936	Steelhead	0.850459035	0.615519331	0.523473976	122.36	122.51	126.33	4.524609543	19.16133342	11.11823978	115.172731	0.978297222	1.08417511	6.847507112	26.79613432	12.33980719	285.7381541	0.89881588	17.2086331	297.7406616	0.614812654	0.416851566
1937	Steelhead	0.909755063	0.583936217	0.53123893	119.71	122.47	130.25	5.189643942	16.7677542	10.47388992	50.86909637	0.975555384	0.73988719	8.805743955	20.0964587	12.27655935	163.9306361	0.941904436	14.36937634	177.5213165	0.656662977	0.395091012
1938	Steelhead	0.913491572	0.630050305	0.575545644	123.24	124.98	129.12	4.058421768	21.31636419	10.93256416	111.5926208	0.980600774	1.078533363	6.265449606	28.88492154	12.6768961	309.0633392	0.897590826	17.66275565	321.1536865	0.690139304	0.448150204
1939	Steelhead	0.802366318	0.541705575	0.434646307	136.79	137.22	140.63	3.784023359	22.54554946	12.28020897	77.29988403	0.990398324	1.119676781	7.0004149	24.85591609	13.55895726	217.2592646	0.941746821	16.69557858	222.8695526	0.55901917	0.33225473
1940	Steelhead	0.82349798	0.546992593	0.450447295	128	127.86	130.79	4.235048972	20.33053601	11.9209219	83.53600616	0.988514972	1.053679466	7.144379333	24.67277149	13.68392642	225.1434631	0.937396894	16.70084667	232.7225494	0.554697113	0.345230135
1941	Steelhead	0.832127208	0.504266707	0.419614047	129.36	130.73	135.77	3.899196826	21.98794612	13.08317108	55.46320648	0.991073382	0.87036314	7.520124942	22.83302499	14.51827113	181.8326035	0.954566091	15.45406675	189.7847443	0.551939979	0.288343674
1942	Steelhead	0.917552221	0.628229877	0.576433719	120.49	122.66	128.8	4.779930487	18.22255614	10.32886944	83.53708801	0.987992167	0.931820011	7.64486187	23.29221131	11.92450428	215.9066315	0.943158627	16.20077324	224.6229248	0.685450254	0.443419254
1943	Steelhead	0.920615211	0.614598601	0.565808821	127.41	129.18	133.97	3.660147779	23.40638228	10.95284805	113.5797653	0.986106718	1.110214424	6.38473323	27.8385642	12.94294373	284.1959178	0.910037011	17.47139057	293.8853149	0.687115113	0.426675698
1944	Steelhead	0.903470054	0.542602786	0.490225368	121.5	123.8	131.1	4.845276706	17.91073999	10.64998608	51.74303818	0.979177606	0.768539858	8.816180743	19.54381663	12.97972536	143.5545247	0.949272662	13.87258673	151.6450348	0.619918796	0.347872411
1945	Steelhead	0.89414054	0.577464351	0.516334286	130.17	131.62	136.48	3.835825458	22.43425551	11.48583412	82.97876587	0.98991282	0.945573616	7.2543758	24.3381576	13.37719472	223.1079356	0.937719891	16.2422967	237.8478851	0.638278256	0.393691244
1946	Steelhead	0.922775542	0.656694446	0.605981574	123.41	125.26	129.45	4.164284848	20.83603337	10.51072006	111.1220093	0.978738654	1.084479046	6.11627008	30.02581722	12.14476029	333.7866007	0.88352409	17.95499404	346.4668579	0.729689476	0.469275654
1947	Steelhead	0.797575669	0.541477883	0.431869584	134.55	134.31	137.01	3.663355961	23.34518438	12.81149673	113.1097534	0.976684475	1.142481327	6.093876682	29.28562637	14.53567791	304.3712311	0.887621462	17.51115513	312.6004944	0.553927564	0.317657177
1948	Steelhead	0.903118334	0.631508482	0.570326888	134.03	135.54	140.69	3.209396958	26.63107371	11.7688179	145.9042328	0.981186414	1.365327549	5.400612846	33.96383038	13.74026092	426.7423147	0.869012952	22.2957557	447.7825623	0.681039441	0.438819051
1949	Steelhead	0.917591166	0.634941196	0.582616433	121.81	123.51	128.26	4.032340311	21.49701404	10.71792965	126.4264862	0.981630754	1.116067791	6.16496218	29.67362489	12.67351087	331.7122192	0.886970262	18.09997145	347.686554	0.697088265	0.469823995
1950	Steelhead	0.912985126	0.635848622	0.580520334	124.46	126.38	132.84	4.443659849	19.464192	10.67598476	91.72471313	0.987944984	1.039714432	7.047333196	25.44040628	12.09106127	255.8590088	0.923167417	16.98757807	269.9475403	0.702310099	0.450698362
1951	Steelhead	0.907930829	0.616968696	0.560164899	122.66	124.58	129.85	4.211160481	20.53115501	11.02642021	101.0824066	0.984333587	1.128641605	6.20365715	29.27401681	13.07548253	315.8403269	0.89308845	17.80695756	329.6502686	0.676759742	0.438115394
1952																						

Columbia River System Operations Environmental Impact Statement
Appendix E: Fish, Aquatic Macroinvertebrates, and Aquatic Habitat

Year	Species	InRivSurvSNK	InRivSurvLCol	InRivSurv	MedDayLGR	MedDayConfl	MedDayBON	SNKTravelTime	SNKMigRate	SNKTemp	SNKFlow	SNKFSpill	SNKGas	LCTravelTime	LCMigRate	LCTemp	LCFlow	LCFSpill	LCGas	BonFlow	monte_q975	monte_q025
1964	Steelhead	0.910044643	0.590657588	0.537524774	131.58	133.47	139.4	3.701803245	23.1592305	11.25650406	93.43356323	0.98772887	1.001938248	6.942563869	25.48777044	13.37106673	251.6714223	0.922464301	16.61736727	263.9472656	0.663831449	0.412042734
1965	Steelhead	0.913610686	0.630493035	0.576025174	131.74	133.53	138.43	4.191693738	20.67736427	11.00301476	126.7678345	0.97758975	1.075537586	6.155276738	29.63252103	12.82973512	322.467687	0.882045647	17.689768	332.0551147	0.680446272	0.462168687
1966	Steelhead	0.882724024	0.57459971	0.507212968	130.04	131.7	137.16	3.621065386	23.54895478	11.65660858	68.36349335	0.994591486	1.049771309	7.033034168	24.80028466	13.42401044	219.2739003	0.94637388	16.63656537	226.5662384	0.658326665	0.361696335
1967	Steelhead	0.891776763	0.619869732	0.552785423	133.7	135.23	140.8	4.346973307	19.85887816	11.26246243	88.02864838	0.977092147	1.000310135	6.910654821	25.83280788	12.71362289	280.2549947	0.902856876	16.9868083	289.3380432	0.665178631	0.438761601
1968	Steelhead	0.833762784	0.538012412	0.448574726	120.06	121.04	126.31	6.023260608	14.49283743	11.95480881	60.48068314	0.949843776	0.730220032	8.685131043	20.06627703	13.15001059	180.5535177	0.904026449	13.75874488	188.7473755	0.567501239	0.348369581
1969	Steelhead	0.911440591	0.608828437	0.55491095	133.28	134.98	140.07	3.040269211	28.01316254	11.6565588	130.6308746	0.976312828	1.213567162	5.435539432	33.39408176	13.97409185	371.5631866	0.866227289	18.85858011	378.5861206	0.693738183	0.420336623
1970	Steelhead	0.916631182	0.615224101	0.563933595	124.14	126.61	134.23	4.484038122	19.35404671	10.59582996	84.63358154	0.981658483	0.838075256	7.778035529	22.75969266	12.27600447	223.7584712	0.923213452	15.51108917	233.4108124	0.67916912	0.43482883
1971	Steelhead	0.89302811	0.631374077	0.563834799	139.89	141.17	145.18	3.31407994	25.79185861	11.97907238	146.3385956	0.970946169	1.223018837	5.224903345	34.96538724	13.57395347	406.21993	0.84994333	19.54330603	412.9869995	0.671413056	0.430797126
1972	Steelhead	0.902140297	0.637185459	0.574830679	128.84	130.39	135.19	4.229539245	20.46731952	11.2472826	124.4462631	0.980565143	1.229454613	5.651298977	32.33838828	13.12061024	383.3737233	0.872650981	19.86900043	385.5175781	0.679108414	0.469003459
1973	Steelhead	0.884094208	0.550659624	0.486834984	117.72	120.58	129.09	5.420190036	16.08074657	10.77659855	50.5571907	0.970337832	0.782455254	8.780433103	19.67366429	12.92595021	155.2285716	0.934637219	14.05164997	161.3557739	0.606970037	0.369026977
1974	Steelhead	0.899441774	0.625077685	0.562220982	134.42	135.93	140.43	3.663339466	23.43826014	11.63127136	126.604895	0.97342732	1.203693771	5.41818957	33.46835929	13.51336686	380.5458934	0.86195448	19.20689106	386.7110291	0.675611635	0.434314725
1975	Steelhead	0.923859465	0.648018005	0.598677567	116.08	118.91	125.67	5.084749795	17.24105092	9.985352707	83.58813782	0.9897874	0.907075596	7.656961821	23.68241752	11.55098232	235.9888535	0.937657426	16.5305961	247.2622681	0.719684797	0.457385912
1976	Steelhead	0.927083727	0.668911762	0.620137209	124.16	125.96	131.04	4.339301363	20.02067125	10.3811409	131.3689972	0.975753379	1.117785358	6.230949216	29.3560437	11.90744702	328.9560852	0.882868926	17.99498018	333.1289978	0.724328737	0.498617897
1977	Steelhead	0.854830545	0.507916062	0.434182164	121.4	123.31	130.15	5.134325884	16.92021407	11.73026485	36.76270905	0.971774149	0.759212065	8.925983585	19.11760693	13.56092087	134.0347252	0.943731358	13.44835385	141.4520569	0.562492852	0.315867929
1978	Steelhead	0.896432857	0.604916457	0.542266987	135.22	136.82	141.78	3.572484337	23.95701216	11.62664471	94.80915222	0.992163098	1.138587379	6.384977207	27.45971185	13.284434	264.6935883	0.924999595	17.45861832	273.6483154	0.66325162	0.40498694
1979	Steelhead	0.914074822	0.628674519	0.574655549	122.38	124.56	130.71	4.639955707	18.70907814	10.59845524	79.38390961	0.984645069	0.919882011	7.518155225	24.01438388	12.09575748	232.9874395	0.930137356	16.23743725	247.1830444	0.711156709	0.449857714
1980	Steelhead	0.915560722	0.64622455	0.591657815	117.37	119.98	124.99	5.150686406	17.09334119	10.20369568	87.52772064	0.976709783	0.924421883	7.029357277	26.49639245	12.01251539	287.3805974	0.902963152	16.91244427	306.3229675	0.69153917	0.462253495
1981	Steelhead	0.813910324	0.526165034	0.428251153	138.32	139.03	143.97	3.643664837	23.52584149	13.57654171	89.95480957	0.97933166	0.988533783	6.491647698	26.99447945	14.90098111	264.7968216	0.91081051	16.69239219	273.5896606	0.552763216	0.308463138
1982	Steelhead	0.89943063	0.616141411	0.554176457	128.49	130.06	135.33	4.399626836	19.67876374	11.18741302	110.3999908	0.97991153	1.117410278	6.333283961	28.78731367	13.02074289	314.4502411	0.890233765	17.85340754	322.8909607	0.661396827	0.438200375
1983	Steelhead	0.909481507	0.620331505	0.564180032	127.95	129.68	134.55	4.556219198	19.11260473	10.90520668	102.5412827	0.982633114	1.036968708	6.596256636	27.50247394	12.86991978	290.219752	0.904457996	17.31657489	301.9002991	0.662619152	0.444448087
1984	Steelhead	0.917008205	0.626049254	0.574092302	126.31	128.16	133.36	4.227654658	20.47733254	10.76446934	123.5200653	0.985661614	1.047274971	6.830230214	26.49914548	12.43791199	266.8156153	0.914784978	17.07453903	275.0581055	0.688786915	0.45148162
1985	Steelhead	0.922143076	0.634497566	0.585097537	122.99	124.9	131.05	4.212798946	20.49175795	10.4731781	95.66685638	0.993110919	1.034306049	7.230438568	24.6442372	12.02175824	235.3912811	0.939843973	16.97562011	242.7809753	0.709160187	0.461108762
1986	Steelhead	0.902688245	0.594979116	0.537080654	128.25	129.89	134.55	4.393635534	19.71052003	11.12368107	106.907579	0.988083303	1.054391479	6.722778492	26.497897	13.2116313	263.4075368	0.918498337	17.1319046	268.0259705	0.645456471	0.431588746
1987	Steelhead	0.746476783	0.506059933	0.377761991	129.38	128.85	131.3	4.569509588	18.76929503	13.29232025	53.87142487	0.980275393	1.024452209	7.223487042	24.49196435	14.34355847	228.9732768	0.923014661	16.22441196	235.3372498	0.504362548	0.276041043
1988	Steelhead	0.902621686	0.579881895	0.523413974	131.7	133.72	139.36	3.902253382	21.89821221	11.27122421	62.38008804	0.99237119	0.945582294	7.460412778	23.21123038	13.06718365	190.0762431	0.955778013	15.8938454	195.8269806	0.649266146	0.389531616
1989	Steelhead	0.926397269	0.6650208	0.616073453	115.62	118.23	124.41	4.655301481	18.70846247	10.01159401	98.01724091	0.993217671	1.056023026	6.976107083	26.29237139	11.40716076	273.5014165	0.920243482	17.33704662	281.1698608	0.729673791	0.466829841
1990	Steelhead	0.745597087	0.474864484	0.354057576	136.93	136.62	138.52	3.96621979	21.54801205	13.97490025	67.22151794	0.984207523	1.066629696	6.733239718	25.93604192	15.26287778	238.7786382	0.924222618	16.64313968	244.7165985	0.502565578	0.257815648
1991	Steelhead	0.877002869	0.597313044	0.523845254	122.91	124.29	128.8	5.363547124	16.28073083	11.08968525	65.26640167	0.97376889	0.961120796	7.12695536	25.38820966	12.9226621	256.1004512	0.910779456	16.57790073	256.1395264	0.622701801	0.418842909
1992	Steelhead	0.77424172	0.490696872	0.37991799	130.56	131.26	135.29	4.13420777	20.70583975	13.44504623	50.56856384	0.985313332	0.95418129	7.432457373	23.37077823	14.62282928	195.4266052	0.944981923	15.84318209	197.9950409	0.505057022	0.283503405
1993	Steelhead	0.920211266	0.633943738	0.58336217	125.22	127.24	134.07	4.2174256	20.55351174	10.50654125	98.73529968	0.981555343	0.870842648	7.389689006	24.41386211	11.98845784	253.91996	0.916448762	16.25932868	264.7316895	0.698906455	0.444052405
1994	Steelhead	0.827803541	0.531643004	0.440095961	127.31	128.07	131.98	4.7330103	18.21650736	11.68439541	60.06785583	0.983887458	0.9752985	7.769652776	22.62711231	13.56304995	194.1081619	0.944515824	15.84584697	200.0101624	0.559372941	0.335729916
1995	Steelhead	0.908746887	0.592635337	0.538555518	121.8	123.93	130.47	4.426675737	19.62098932	10.81963711	87.48014526	0.989782321	0.947387218	7.407452643	23.97555011	12.96274233	228.0972239	0.93589897	16.22116502	239.1461639	0.653703473	0.405524276
1996	Steelhead	0.877078161	0.616550471	0.540762953	129.45	130.63	133.75	4.436069004	19.56990464	11.83000622	121.2668213	0.973672843	1.074608707	6.026314557	30.05009111	13.01077096	330.6763814	0.879690925	17.81742827	343.4128113	0.642904358	0.440931688
1997	Steelhead	0.912725992	0.643923376	0.587725602	135.72	137.14	140.92	3.386271462	25.34920596	11.54818172	168.031073	0.970996034	1.42218523	4.844352908	37.99200177	13.65971041	468.9469503	0.841754397	22.44833422	475.1591492	0.692605785	0.46719943
1998	Steelhead	0.906900917	0.602587508	0.546487163	129.15	130.78	135.79	3.337499209	25.65949105	11.59333324	121.8556549	0.979257667	1.062734127	6.006689675	30.23161477	13.7414314	324.8388163	0.886165162	17.73034509	336.7099609	0.687306628	0.41846539
1999	Steelhead	0.893815669	0.595030232	0.531847345	134.06	135.92	142.04	3.757216603	22.89420596	11.72446156	105.5274368	0.98576175	1.089112186	6.143010169	29.10077516	13.64578549	302.457					

Year	Species	InRivSurvSNK	InRivSurvLCol	InRivSurv	MedDayLGR	MedDayConfl	MedDayBON	SNKTravelTime	SNKMigRate	SNKTemp	SNKFlow	SNKFSpill	SNKGas	LCTravelTime	LCMigRate	LCTemp	LCFlow	LCFSpill	LCGas	BonFlow	monte_q975	monte_q025
2001	Steelhead	0.887249814	0.523773786	0.464718194	130.47	132.4	138.82	4.152715206	20.73571502	11.52562504	57.93331604	0.985485792	0.843837357	7.896692567	21.62671677	13.89762529	163.7508443	0.952697535	14.73141964	172.219162	0.597719821	0.353800444
2002	Steelhead	0.910358766	0.616942096	0.561638646	124.63	126.59	131.4	4.436862983	19.50474867	10.76114769	76.34583435	0.988982272	1.076717091	6.938207559	25.62714146	12.57362286	253.9883092	0.92872416	17.23500061	264.1842346	0.670026908	0.442031061
2003	Steelhead	0.904135963	0.588270552	0.531876562	126.39	128.41	134.65	4.038047165	21.3457172	11.20576553	79.72070923	0.990386903	1.011466408	6.964268513	25.33419635	13.27935632	243.8407974	0.934437195	16.92016856	262.9431763	0.657872429	0.413764427
2004	Steelhead	0.897717118	0.560253103	0.502948801	131.04	132.94	138.95	3.646626271	23.49613398	11.65357285	76.13249359	0.995143247	1.055051708	6.862370744	25.30407886	13.95194117	226.0559362	0.944763601	16.80724573	247.2705688	0.647893563	0.382017541
2005	Steelhead	0.847636736	0.52316738	0.443455891	130.84	132.07	137.09	3.679081395	23.34269015	12.91405163	79.7695343	0.992021084	1.001525784	6.988527745	24.75461613	14.57389657	217.2708486	0.942850262	16.31297414	224.1720581	0.607037163	0.320992881
2006	Steelhead	0.919592042	0.661156729	0.607994466	123.39	125.04	129.75	4.640461057	18.8351272	10.41577911	131.9135956	0.977856886	1.103369999	6.311378852	29.06700254	11.98360809	327.2440948	0.888694108	18.05902004	338.9646301	0.711538666	0.483634659
2007	Steelhead	0.856724783	0.565605943	0.484568629	119.84	121.62	126.88	4.516054206	19.25804403	11.9668602	62.26437759	0.993400764	1.07820425	6.971380718	25.22022076	13.69916789	236.2321192	0.940188219	17.0453976	244.1781616	0.600561271	0.363532554
2008	Steelhead	0.893723276	0.598397532	0.534801802	130.37	131.68	137.64	3.928961128	21.99711958	11.46669712	104.263472	0.980663323	0.972412586	6.90284624	25.67813058	13.25769726	279.2753042	0.908605347	16.87077363	294.5507202	0.641787377	0.427433185

13 Table 4-12. Snake River_MO3_Steelhead_Wildfish_SAL_W_Raw_Data

Year	Species	InRivSurvSNK	InRivSurvLCol	InRivSurv	MedDayLGR	MedDayConfl	MedDayBON	meanTravelTime	meanMigRate	meanTemp	meanFlow	meanFSpill	meanGas	SNKTravelTime	SNKMigRate	SNKTemp	SNKFlow	SNKFSpill	SNKGas	LCTravelTime	LCMigRate	LCTemp	LCFlow	LCFSpill	LCGas	BonFlow
MO3-Steelhead-SAL-W																										
1929	Steelhead	0.896404826	0.571039917	0.511882937	128.47	130.27	137.14	14.6904031	29.8010424	12.26719148	131.9614964	0.96689825	9.812928268	4.393150523	19.64609822	11.05545006	63.82778244	0.974110901	0.793209839	8.325703539	20.77532741	12.71041298	165.2558823	0.94433701	14.47081327	176.1743622
1930	Steelhead	0.754506966	0.445931262	0.336458243	140.16	140.21	143.9	13.47813004	31.41538465	14.51984692	125.9850028	0.971818669	9.894554581	3.86003042	22.08241311	13.21075382	62.70593262	0.980686951	0.905415058	7.676576369	22.01295795	15.08405574	159.0710602	0.950338036	14.53180631	164.8411865
1931	Steelhead	0.819409272	0.458468214	0.375673105	138.02	139.24	144.35	12.94878586	32.33893092	14.37843459	126.0581147	0.975764879	10.09352599	3.587064728	23.73527577	12.62741623	58.86043243	0.985122597	0.958304501	7.430862457	22.60805598	15.1371115	161.9909617	0.955849608	14.92684746	167.0647125
1932	Steelhead	0.91996341	0.648825389	0.596895617	121.13	123.49	129.15	12.80120362	32.87117245	11.76084593	226.7127756	0.956338653	11.94096463	4.242455661	20.46083254	10.53812847	99.57953033	0.986093152	1.09147625	6.562688716	27.65688017	12.20236142	292.7534739	0.909712543	17.6472524	304.4034424
1933	Steelhead	0.891480232	0.584862239	0.521393124	127.65	129.55	135.13	13.43024553	31.73575821	12.76906545	188.5101525	0.965664268	11.46474927	4.456168808	19.43170886	11.33985081	68.18749084	0.986501265	1.023069382	7.002431899	25.46972724	13.36310768	247.8376668	0.931132505	16.95358578	263.3063965
1934	Steelhead	0.708992631	0.486899033	0.345207826	138.63	138.2	139.62	11.68831963	34.68677586	15.11423629	205.5833372	0.953352554	11.80981626	3.76440233	22.63763276	14.37220631	59.37915726	0.983420825	1.198201275	5.973354764	29.3362088	15.45294841	285.1776174	0.904972027	17.56307713	290.414032
1935	Steelhead	0.892439992	0.568527258	0.507376461	125.94	127.93	134.37	13.13129661	32.08763834	12.89805814	169.9154505	0.972983233	11.13160787	4.002016	21.47374829	11.40548744	67.98436737	0.990592241	1.019650269	7.161100432	24.5321205	13.51721954	221.4830983	0.944801132	16.59886614	232.6900024
1936	Steelhead	0.850459035	0.615153753	0.523163068	122.36	122.51	126.32	13.37226599	31.99789668	12.00554235	227.6449416	0.947737443	11.65316159	4.524609543	19.16133342	11.11823978	115.172731	0.975376761	1.08417511	6.845698081	26.79758604	12.33924675	285.7288717	0.898573518	17.20836957	297.729248
1937	Steelhead	0.909755063	0.582934194	0.530327334	119.71	122.47	130.26	15.98717996	28.32357712	11.80798531	127.3985122	0.962780105	9.797025187	5.189643942	16.7677542	10.47388992	50.86909637	0.968173623	0.73988719	8.802955754	20.09958681	12.27727111	163.9454905	0.939676225	14.36970027	177.538147
1938	Steelhead	0.913491572	0.629452101	0.574999189	123.24	124.98	129.13	12.3138027	33.74314323	12.17873921	240.9947248	0.947262338	12.0618047	4.058421768	21.31636419	10.93256416	111.5926208	0.976840365	1.078533363	6.265184641	28.88492303	12.67711544	309.0469716	0.8962454	17.66308657	321.133606
1939	Steelhead	0.802366318	0.541582389	0.434547467	136.79	137.22	140.62	12.74495174	32.64615233	13.18779148	168.3353697	0.971105209	11.15679455	3.784023359	22.54554946	12.28020897	77.29988403	0.988464439	1.119676781	6.997837365	24.85919797	13.5583245	217.2661413	0.942191809	16.695714	222.8780975
1940	Steelhead	0.82349798	0.546841307	0.450322712	128	127.86	130.79	13.35300651	31.68594351	13.18409395	176.3523216	0.968566622	11.17214523	4.235048972	20.33053601	11.9209219	83.53600616	0.98658694	1.053679466	7.142016239	24.67560984	13.684069	225.1424789	0.937833438	16.70150312	232.7208252
1941	Steelhead	0.832127208	0.503737219	0.419173446	129.36	130.73	135.78	13.3693856	31.65449569	14.10769027	138.9375202	0.975161276	10.39265425	3.899196826	21.98794612	13.08317108	55.46320648	0.986245465	0.87036314	7.517467774	22.836874	14.51884794	181.8448893	0.953505298	15.45467186	189.797287
1942	Steelhead	0.917552221	0.627840222	0.57607619	120.49	122.66	128.79	14.41910315	30.1966893	11.48618119	170.7191195	0.970182423	10.90007683	4.779930487	18.22255614	10.32886944	83.53708801	0.984999812	0.931820011	7.642332897	23.29446025	11.92397992	215.9031448	0.942926079	16.20080868	224.6186981
1943	Steelhead	0.920615211	0.614077813	0.565329376	127.41	129.18	133.98	12.02230027	34.12352866	12.38153321	225.2550218	0.954753688	11.82585185	3.660147779	23.40638228	10.95284805	113.5797653	0.982401347	1.110214424	6.383756667	27.83944706	12.94324907	284.1781362	0.909091065	17.47166268	293.8611755
1944	Steelhead	0.903470054	0.541207943	0.488965169	121.5	123.8	131.12	15.63605687	28.61288358	12.33884668	113.0638065	0.965468556	9.408438018	4.845276706	17.91073999	10.64998608	51.74303818	0.968567264	0.768539858	8.813144244	19.54814187	12.98106003	143.5787404	0.945620914	13.87370284	151.6728058
1945	Steelhead	0.89414054	0.576922248	0.51584957	130.17	131.62	136.49	13.05012961	32.38505635	12.84752757	177.7131097	0.967704288	10.95538126	3.835825458	22.43425551	11.48583412	82.97876587	0.98515538	0.945573616	7.251101561	24.34368619	13.37795035	223.1308111	0.937013775	16.24321922	237.8730774
1946	Steelhead	0.922775542	0.655895	0.605243865	123.41	125.26	129.44	12.27909513	34.00281059	11.71827977	257.3234449	0.939967935	12.30365852	4.164284848	20.83603337	10.51072006	111.1220093	0.974023485	1.084479046	6.116214268	30.02521818	12.14410003	333.778595	0.881572475	17.95494731	346.4560547
1947	Steelhead	0.797575669	0.540885825	0.431397373	134.55	134.31	137.01	11.71702075	34.85703654	14.00953123	237.9927455	0.94125651	11.88470095	3.663355961	23.34518438	12.81149673	113.1097534	0.97232554	1.142481327	6.094646141	29.28435935	14.53563754	304.3618571	0.885994087	17.51255353	312.5887756
1948	Steelhead	0.903118334	0.631305389	0.570143471	134.03	135.54	140.69	10.55981775	38.09768976	13.17186655	333.9721407	0.936447889	15.01345338	3.209396958	26.63107371	11.7688179	145.9042328	0.979774594	1.365327549	5.39969667	33.96816029	13.74065876	426.8279521	0.868566344	22.30034447	447.8822632

Columbia River System Operations Environmental Impact Statement
Appendix E: Fish, Aquatic Macroinvertebrates, and Aquatic Habitat

Year	Species	InRivSurvSNK	InRivSurvLCol	InRivSurv	MedDayLGR	MedDayConfl	MedDayBON	meanTravelTime	meanMigRate	meanTemp	meanFlow	meanFSpill	meanGas	SNKTravelTime	SNKMigRate	SNKTemp	SNKFlow	SNKFSpill	SNKGas	LCTravelTime	LCMigRate	LCTemp	LCFlow	LCFSpill	LCGas	BonFlow
1949	Steelhead	0.917591166	0.634372325	0.582094442	121.81	123.51	128.25	12.18857423	34.13829041	12.13196571	262.2676424	0.943072362	12.43976821	4.032340311	21.49701404	10.71792965	126.4264862	0.978182292	1.116067791	6.164983585	29.67255352	12.67280149	331.6941121	0.885350287	18.09996668	347.6619873
1950	Steelhead	0.912985126	0.635457779	0.580163501	124.46	126.38	132.84	13.48336121	31.58020181	11.71838331	201.1007069	0.961538	11.46444702	4.443659849	19.464192	10.67598476	91.72471313	0.984980965	1.039714432	7.045705281	25.44235245	12.09090662	255.8538691	0.922771196	16.98868052	269.9395142
1951	Steelhead	0.907930829	0.616369772	0.559621118	122.66	124.58	129.85	12.40424615	33.63288076	12.46608141	242.5362429	0.946559727	12.16466675	4.211160481	20.53115501	11.02642021	101.0824066	0.980360174	1.128641605	6.203357816	29.27416354	13.07579199	315.8279978	0.891672671	17.8077507	329.6332092
1952	Steelhead	0.930403833	0.66459178	0.618338739	124.93	126.49	131.21	11.35887052	35.93475138	11.72425359	288.7621896	0.929921563	12.59262535	3.523328915	24.39091469	10.622118	157.7349426	0.966235697	1.086239433	5.842468381	31.48243413	12.13604196	357.28007	0.864620755	18.16772699	369.9448547
1953	Steelhead	0.91486358	0.604863365	0.553367463	127.19	129.18	136.27	12.70982394	33.08275918	12.54663195	204.6941823	0.961469105	11.50668877	3.912724376	22.08310465	11.01538754	88.15855408	0.984715104	0.969183064	6.834892482	26.24720046	13.15260172	261.2789459	0.922832231	16.92359845	278.2189331
1954	Steelhead	0.920909794	0.661244028	0.608946102	117.12	119.93	126.3	14.79098624	30.05340737	10.99621698	204.3438557	0.956318391	11.44937801	5.48339463	16.06096309	9.953236961	88.78773804	0.977041471	0.964610481	7.295789771	24.99873909	11.35473903	263.4564692	0.917208294	16.85367537	276.7309875
1955	Steelhead	0.921401486	0.602268958	0.554931513	124.58	126.71	133.4	13.71990601	31.27777219	12.09313447	166.5437306	0.971612875	10.82916185	4.100961283	21.03157386	10.66366043	75.5759552	0.986783171	0.91504631	7.641855322	23.1567349	12.63532925	210.1684723	0.944777449	16.02111959	224.2757568
1956	Steelhead	0.923707759	0.665256989	0.614503043	129.3	130.96	135.48	11.15779965	36.54559224	12.04162298	316.0960312	0.929616962	13.95741708	3.705699094	23.23676113	10.84546814	140.7667145	0.972359431	1.260844994	5.470093057	33.69120031	12.50961304	406.4513397	0.858806868	20.13726346	425.0957947
1957	Steelhead	0.912058643	0.655116728	0.597504874	123.68	125.44	130.56	12.82195249	33.07223746	11.81478725	272.3798054	0.939958743	12.87788486	4.441955186	19.57622505	10.6985424	129.0360443	0.971823204	1.077175713	6.392706625	28.72279211	12.24508826	343.898763	0.883384575	18.62545125	359.8013916
1958	Steelhead	0.914431104	0.634091248	0.579832759	128.65	130.25	135.06	11.9406608	34.70194219	12.3467583	260.549802	0.9428544	12.49372935	3.725073703	23.05621371	11.13103008	121.8859909	0.977464724	1.110761166	6.243437193	29.37893042	12.81623046	329.7028198	0.885439843	18.1510663	346.9575806
1959	Steelhead	0.89208689	0.613008303	0.546856671	119.53	121.69	126.24	14.76778347	30.1562858	12.03590952	199.065039	0.95097919	11.40426036	5.627502717	15.54205756	10.72065678	74.9362381	0.972634828	1.015288353	7.138924807	25.50613699	12.56564871	263.2004064	0.90842254	16.87761482	274.5927429
1960	Steelhead	0.922308219	0.637874888	0.588317251	120.6	122.97	129.39	13.69646057	31.20276382	11.56604201	188.2282273	0.968487429	11.47125973	4.520997494	19.15787331	10.28928757	78.78773651	0.990476835	1.079260635	7.177119248	24.88618735	12.01937548	244.914149	0.934406737	17.10504611	255.4072266
1961	Steelhead	0.902179407	0.603335601	0.544316955	123.79	125.95	132.52	13.18393351	32.18153446	12.50072799	203.4429616	0.960180708	11.77518913	4.385648131	19.70446374	11.00650787	69.32971191	0.984991562	1.029169464	6.823941484	26.3265859	13.10534016	271.1065089	0.91959552	17.31670062	282.6031494
1962	Steelhead	0.914574859	0.594138511	0.543384145	129.55	131.39	136.98	12.04290108	34.21184552	12.81871768	197.3885351	0.967485057	11.62434677	3.489296585	24.46415093	11.24126205	88.10972443	0.992872059	1.155988216	6.59190388	26.88953721	13.44484234	255.4638316	0.930072029	17.36542559	261.2952271
1963	Steelhead	0.892552256	0.565345186	0.504600121	133.49	135.4	142.46	12.27116186	33.82649701	13.24885055	193.6091505	0.963256385	11.19430143	3.54872144	24.1229229	11.79104404	88.84111328	0.98587724	0.971642017	6.771930575	26.08834697	13.88220739	244.9275767	0.926034003	16.53777138	257.5349426
1964	Steelhead	0.910044643	0.590160707	0.53707259	131.58	133.47	139.4	12.60285743	33.15701848	12.76793991	199.7732271	0.960731907	11.30988073	3.701803245	23.1592305	11.25650406	93.43356323	0.984154284	1.001938248	6.940950558	25.48944899	13.37088076	251.6681188	0.921579401	16.61735519	263.9403992
1965	Steelhead	0.913610686	0.629833609	0.575422716	131.74	133.53	138.43	12.32088589	33.94780255	12.29197018	255.38157	0.939238242	12.11537303	4.191693738	20.67736427	11.00301476	126.7678345	0.973510313	1.075537586	6.15517012	29.63224419	12.82986371	322.4585775	0.880297412	17.69013834	332.0427246
1966	Steelhead	0.882724024	0.574365486	0.507006213	130.04	131.7	137.16	12.61358846	32.9868625	12.93779312	166.8604088	0.974249985	11.12703167	3.621065386	23.54895478	11.65660858	68.36349335	0.991987193	1.049771309	7.030211627	24.80395581	13.42392826	219.2793859	0.946594139	16.63671478	226.5714874
1967	Steelhead	0.891776763	0.619167066	0.552158802	133.7	135.23	140.79	13.22597993	32.06110972	12.31103182	214.9551343	0.947856699	11.65162502	4.346973307	19.85887816	11.26246243	88.02864838	0.97277869	1.000310135	6.909792483	25.83360641	12.71366739	280.2532043	0.90101703	16.9868385	289.3319397
1968	Steelhead	0.833762784	0.537151541	0.447856964	120.06	121.04	126.33	16.69867621	27.51154098	12.82771533	139.7531981	0.938026828	9.454073702	6.023260608	14.49283743	11.95480881	60.48068314	0.944121838	0.730220032	8.68285957	20.06958108	13.15027205	180.5879059	0.901961118	13.75906738	188.7899323
1969	Steelhead	0.911440591	0.608080323	0.554229089	133.28	134.98	140.07	10.42942146	38.33578401	13.2619007	288.1538402	0.931372217	13.06856319	3.040269211	28.01316254	11.6565588	130.6308746	0.972158599	1.213567162	5.437374316	33.38939944	13.97395102	371.5442505	0.86307024	18.85852321	378.5610046
1970	Steelhead	0.916631182	0.61409177	0.562895665	124.14	126.61	134.25	14.23804001	30.50239954	11.81106744	178.0109002	0.956729467	10.58697483	4.484038122	19.35404671	10.59582996	84.63358154	0.974328196	0.838075256	7.775784224	22.76421079	12.27672784	223.8004303	0.920428882	15.51220163	233.4580688
1971	Steelhead	0.89302811	0.630541584	0.563091359	139.89	141.17	145.18	10.49255757	38.22305845	13.11152363	315.489599	0.922002839	13.61467123	3.31407994	25.79185861	11.97907238	146.3385956	0.966742754	1.223018837	5.227717862	34.96089115	13.57466586	406.2317403	0.845721215	19.54440562	412.9949951
1972	Steelhead	0.902140297	0.636711596	0.574403188	128.84	130.39	135.19	11.8616612	34.99206515	12.5640876	292.3843596	0.936512104	13.57053082	4.229539245	20.46731952	11.2472826	124.4462631	0.977871096	1.229454613	5.652454056	32.33640582	13.12094402	383.3801015	0.870302548	19.8700091	385.5190125
1973	Steelhead	0.884094208	0.549208852	0.485552365	117.72	120.58	129.12	16.17233185	28.03116051	12.33934239	119.7222947	0.956114262	9.49973791	5.420190036	16.08074657	10.77659855	50.5571907	0.960029137	0.782455254	8.776689447	19.68054163	12.92711322	155.299174	0.930909137	14.05418976	161.4383545
1974	Steelhead	0.899441774	0.624284421	0.561507487	134.42	135.93	140.43	11.04653275	36.65177157	12.94926664	291.926651	0.928405174	13.23532758	3.663339466	23.43826014	11.63127136	126.604895	0.968927085	1.203693771	5.419813067	33.46581328	13.51407115	380.5506388	0.858839711	19.20763842	386.7105408
1975	Steelhead	0.923859465	0.647633015	0.59832189	116.08	118.91	125.67	14.74587251	29.94705897	11.17241246	185.0690057	0.968413076	11.16902048	5.084749795	17.24105092	9.985352707	83.58813782	0.986825144	0.907075596	7.654547423	23.68420261	11.55060228	235.9760844	0.937276651	16.53046974	247.2454376
1976	Steelhead	0.927083727	0.66823646	0.619511148	124.16	125.96	131.03	12.5692744	33.42762487	11.48622635	259.6373825	0.938790509	12.30300062	4.339301363	20.02067125	10.3811409	131.3689972	0.971814954	1.117785358	6.231880978	29.35485936	11.90723133	328.9482981	0.88066557	17.99603844	333.1175842
1977	Steelhead	0.854830545	0.506443257	0.432923166	121.4	123.31	130.17	16.03478179	28.0775104	13.05351714	101.3601641	0.959751274	9.172592657	5.134325884	16.92021407	11.73026485	36.76270905	0.959896874	0.759212065	8.922971085	19.12217536	13.56270027	134.0565478	0.939505806	13.44926604	141.4758759
1978	Steelhead	0.896432857	0.604640457	0.542019572	135.22	136.82	141.78	11.91455506	34.29546643	12.80969231	206.2044558	0.964249994	11.70258604	3.572484337	23.95701216	11.62664471	94.80915222	0.98975966	1.138587379	6.383111857	27.46213798	13.28427315	264.687856	0.925116976	17.45926269	273.6417542
1979																										

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Appendix E: Fish, Aquatic Macroinvertebrates, and Aquatic Habitat

Year	Species	InRivSurvSNK	InRivSurvLCol	InRivSurv	MedDayLGR	MedDayConfl	MedDayBON	meanTravelTime	meanMigRate	meanTemp	meanFlow	meanFSpill	meanGas	SNKTravelTime	SNKMigRate	SNKTemp	SNKFlow	SNKFSpill	SNKGas	LCTravelTime	LCMigRate	LCTemp	LCFlow	LCFSpill	LCGas	BonFlow
1986	Steelhead	0.902688245	0.594550628	0.536693863	128.25	129.89	134.55	13.09313963	32.23737845	12.59580292	209.3644338	0.959243208	11.58007022	4.393635534	19.71052003	11.12368107	106.907579	0.984920347	1.054391479	6.722394064	26.49775632	13.21190659	263.3848216	0.917467376	17.13381863	267.9951477
1987	Steelhead	0.746476783	0.505773066	0.377547851	129.38	128.85	131.3	13.76637621	31.05257493	14.04319845	168.3345604	0.958828236	10.951234	4.569509588	18.76929503	13.29232025	53.87142487	0.977344573	1.024452209	7.221199922	24.49481226	14.34364557	228.9779104	0.922812204	16.22440561	235.3420563
1988	Steelhead	0.902621686	0.579504614	0.523073432	131.7	133.72	139.36	13.32203571	31.71900886	12.56176267	145.8022605	0.977039052	10.65818095	3.902253382	21.89821221	11.27122421	62.38008804	0.989153194	0.945582294	7.457929961	23.21398356	13.06708066	190.0783056	0.955464125	15.89397049	195.8286591
1989	Steelhead	0.926397269	0.664796527	0.615865687	115.62	118.23	124.41	13.64540346	31.52288884	11.08965383	212.3228809	0.962908796	11.65472235	4.655301481	18.70846247	10.01159401	98.01724091	0.991396689	1.056023026	6.973574802	26.29494385	11.40660222	273.4951248	0.920623322	17.33699958	281.1626282
1990	Steelhead	0.745597087	0.474648491	0.353896532	136.93	136.62	138.51	12.65184842	32.81525955	14.85986805	179.3041447	0.960842354	11.20487162	3.96621979	21.54801205	13.97490025	67.22151794	0.981518626	1.066629696	6.731493987	25.93729849	15.26178217	238.7616043	0.924033235	16.64286184	244.6963959
1991	Steelhead	0.877002869	0.59679563	0.52339148	122.91	124.29	128.78	14.47335794	30.48821087	12.40262549	187.9787243	0.950566232	11.2106593	5.363547124	16.28073083	11.08968525	65.26640167	0.969998372	0.961120796	7.12571834	25.38798326	12.92166773	256.0743535	0.909656028	16.57759333	256.1080933
1992	Steelhead	0.77424172	0.490383641	0.379675473	130.56	131.26	135.29	13.52663567	31.35552539	14.29576193	144.3361097	0.9698715	10.6165108	4.13420777	20.70583975	13.44504623	50.56856384	0.981991863	0.95418129	7.429714419	23.37445593	14.623185	195.4363073	0.944707225	15.8434763	198.0050201
1993	Steelhead	0.920211266	0.632925429	0.582425111	125.22	127.24	134.08	13.59366623	31.56992337	11.58059556	202.262582	0.954100336	11.14881614	4.2174256	20.55351174	10.50654125	98.73529968	0.974922895	0.870842648	7.388041213	24.41722758	11.98913002	253.9434636	0.913797706	16.25999912	264.7550354
1994	Steelhead	0.827803541	0.531351637	0.439854767	127.31	128.07	131.98	14.47837869	30.03766078	13.02091994	147.6908635	0.969318403	10.64168562	4.7330103	18.21650736	11.68439541	60.06785583	0.980907679	0.9752985	7.767056376	22.62992239	13.56300735	194.1123047	0.944320043	15.84593693	200.0139771
1995	Steelhead	0.908746887	0.592188681	0.53814962	121.8	123.93	130.48	13.81177753	31.10469246	12.35187217	181.5303901	0.967459449	10.97301344	4.426675737	19.62098932	10.81963711	87.48014526	0.986372507	0.947387218	7.404938459	23.97839651	12.96270116	228.0995255	0.9354286	16.22127978	239.147522
1996	Steelhead	0.877078161	0.615724429	0.54003845	129.45	130.63	133.75	12.44544799	33.67332566	12.67935487	259.0679692	0.936080281	12.25352836	4.436069004	19.56990464	11.83000622	121.2668213	0.968479455	1.074608707	6.02707161	30.05011559	13.01149336	330.6813405	0.87712127	17.81916173	343.4185181
1997	Steelhead	0.912725992	0.643458548	0.587301342	135.72	137.14	140.93	10.19197518	39.3045496	13.01722057	363.378224	0.919678041	15.42506501	3.386271462	25.34920596	11.54818172	168.031073	0.968839431	1.42218523	4.846818946	37.98874912	13.66071256	468.9846547	0.838549554	22.45047681	475.2016907
1998	Steelhead	0.906900917	0.601887022	0.545851892	129.15	130.78	135.79	11.30724543	36.06225659	13.10460813	256.5141176	0.941349136	12.18099741	3.337499209	25.65949105	11.59333324	121.8556549	0.974756372	1.062734127	6.006902918	30.22985231	13.74107583	324.8168081	0.884184559	17.73003006	336.6830444
1999	Steelhead	0.893815669	0.594501831	0.531375052	134.06	135.92	142.04	11.85955728	34.61554398	13.07157217	236.3191534	0.951224791	12.09714491	3.757216603	22.89420596	11.72446156	105.5274368	0.982365906	1.089112186	6.143094279	29.09935741	13.6460735	302.4278666	0.900886416	17.69173161	315.5150146
2000	Steelhead	0.824931131	0.556958468	0.459452379	130.36	130.8	134.16	12.88489687	32.47881181	13.13036755	198.2044242	0.959053057	11.5007454	4.224003628	20.3734445	12.00434418	87.68536072	0.982182956	1.138268375	6.684191749	26.50257865	13.6058917	256.4974238	0.919304729	17.12521998	265.7667847
2001	Steelhead	0.887249814	0.52294785	0.463985382	130.47	132.4	138.84	13.99965039	30.6883533	13.19695881	127.9569114	0.971107858	9.966864347	4.152715206	20.73571502	11.52562504	57.93331604	0.978329206	0.843837357	7.893892735	21.63122255	13.89833816	163.7743759	0.950644324	14.73255483	172.2448273
2002	Steelhead	0.910358766	0.616677521	0.561397787	124.63	126.59	131.39	13.35859008	31.73186094	12.07606132	193.1916286	0.964734388	11.5809836	4.436862983	19.50474867	10.76114769	76.34583435	0.986728215	1.076717091	6.936025716	25.62897842	12.57294257	253.9735031	0.928773522	17.23485851	264.1651001
2003	Steelhead	0.904135963	0.587968439	0.531603411	126.39	128.41	134.65	12.97119824	32.36773198	12.66671753	190.723453	0.967502049	11.45682519	4.038047165	21.3457172	11.20576553	79.72070923	0.98791306	1.011466408	6.962341554	25.33547975	13.27903112	243.8197556	0.934244315	16.9199454	262.9151917
2004	Steelhead	0.897717118	0.560094069	0.502806034	131.04	132.94	138.95	12.45744734	33.26364764	13.26545429	177.3298225	0.974075586	11.28693434	3.646626271	23.49613398	11.65357285	76.13249359	0.993168795	1.055051708	6.859718755	25.30734066	13.95177682	226.0572713	0.94520243	16.80732616	247.2725983
2005	Steelhead	0.847636736	0.52285382	0.443190105	130.84	132.07	137.09	12.61516074	32.98096231	14.09226193	170.1905583	0.971397379	10.9598498	3.679081395	23.34269015	12.91405163	79.7695343	0.988760328	1.001525784	6.986027204	24.75823172	14.57412704	217.2787654	0.942627261	16.31330252	224.1812439
2006	Steelhead	0.919592042	0.660580536	0.607464604	123.39	125.04	129.75	12.95549957	32.84438801	11.54980333	261.0300369	0.942389122	12.36151535	4.640461057	18.8351272	10.41577911	131.9135956	0.974347353	1.103369999	6.311602302	29.06721581	11.98368835	327.2444916	0.886952817	18.06009102	338.9604187
2007	Steelhead	0.856724783	0.565398439	0.484390855	119.84	121.62	126.88	13.46164923	31.53172234	13.20548848	176.1893193	0.971265814	11.3852335	4.516054206	19.25804403	11.9668602	62.26437759	0.991027617	1.07820425	6.968790829	25.22302901	13.69871505	236.2296727	0.940430661	17.04551776	244.1757355
2008	Steelhead	0.893723276	0.597704034	0.534182007	130.37	131.68	137.64	12.79607765	32.7916808	12.75771366	221.3850822	0.951376293	11.69298611	3.928961128	21.99711958	11.46669712	104.263472	0.976369822	0.972412586	6.902672775	25.67764118	13.25759125	279.2654114	0.906236847	16.87066269	294.5325928