UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
West Coast Region
1201 NE Lloyd Boulevard, Suite 1100
Portland, Oregon 97232-1274

Refer to NMFS No: WCRO-2019-03621

May 12, 2020

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Michelle Walker
Chief, Regulatory Branch
Seattle District, U.S. Army Corps of Engineers
P.O. Box 3755
Seattle, WA 98124-3755

Re: Endangered Species Act Section 7(a)(2) Biological Opinion, and Magnuson–Stevens Fishery Conservation and Management Act Essential Fish Habitat Response for the AgriNorthwest Intake Screen Replacement Project, John Day Reservoir (HUC 17070101) in the Middle Columbia River, Benton County, Washington.

Dear Ms. Walker:

Thank you for your letter of December 9, 2019, requesting initiation of consultation with NOAA's National Marine Fisheries Service (NMFS) pursuant to section 7 of the Endangered Species Act of 1973 (ESA) (16 U.S.C. 1531 et seq.) for the AgriNorthwest Intake Screen Replacement Project (Project). This consultation was conducted in accordance with the 2019 revised regulations that implement section 7 of the ESA (50 CFR 402, 84 FR 45016).

Thank you, also, for your request for consultation pursuant to the essential fish habitat (EFH) provisions in Section 305(b) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA)(16 U.S.C. 1855(b)) for this action. We have included the results of that review in Section 3 of this document.

After reviewing the current status of the species, the environmental baseline, the effects of the proposed action and the cumulative effects, NMFS concludes that the proposed action is not likely to jeopardize the continued existence of ESA-listed Upper Columbia River (UCR) spring-run Chinook salmon (*Oncorhynchus tshawytscha*), UCR steelhead (*O. mykiss*), Middle Columbia River steelhead, Snake River Basin steelhead, Snake River (SR) spring/summer-run Chinook salmon, SR fall-run Chinook salmon, or SR sockeye salmon (*O. nerka*). NMFS also determined that the action will not destroy or adversely modify designated critical habitats for these species. Rationale for our conclusions is provided in the attached biological opinion (opinion). The enclosed opinion is based on information provided in your biological assessment, email discussions, and other sources of information cited in the opinion.

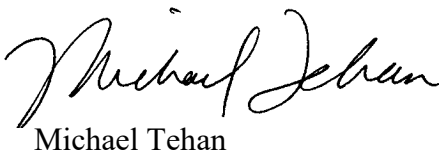
As required by section 7 of the ESA, NMFS provided an incidental take statement (ITS) with the opinion. The ITS includes reasonable and prudent measures (RPMs) that NMFS considers

necessary or appropriate to minimize incidental take associated with the proposed action. The take statement sets forth nondiscretionary terms and conditions, including reporting requirements that the U.S. Army Corps of Engineers (Corps) and any person who performs the action must comply with to carry out the RPMs. Incidental take from the proposed action that meets these terms and conditions will be exempt from the ESA take prohibition.

Our EFH analysis includes two conservation recommendations to avoid, minimize, or otherwise offset potential adverse effects to EFH. If your response is inconsistent with the EFH conservation recommendations, the Corps must explain why, including the justification for any disagreements over the effects of the action and the recommendations. In response to increased oversight of overall EFH program effectiveness by the Office of Management and Budget, NMFS established a quarterly reporting requirement to determine how many conservation recommendations are provided as part of each EFH consultation and how many are adopted by the action agency. Therefore, in your statutory reply to the EFH portion of this consultation, we ask that you clearly identify the number of conservation recommendations accepted.

Please contact Colleen Fagan, La Grande, Oregon, (541) 962-8512 or colleen.fagan@noaa.gov, if you have any questions concerning this consultation, or if you require additional information.

Sincerely,



Michael Tehan
Assistant Regional Administrator
Interior Columbia Basin Office
NOAA Fisheries, West Coast Region

Endangered Species Act (ESA) Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response

AgriNorthwest Intake Screen Replacement Project

NMFS Consultation Number: WCRO-2019-03621

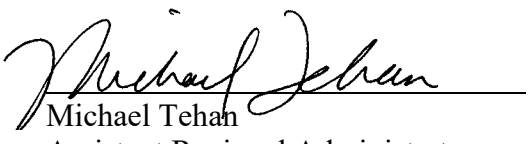
Action Agency: U.S. Army Corps of Engineers, Seattle District

Affected Species and NMFS' Determinations:

ESA-Listed Species	Status	Is Action Likely to Adversely Affect Species?	Is Action Likely To Jeopardize the Species?	Is Action Likely to Adversely Affect Critical Habitat?	Is Action Likely To Destroy or Adversely Modify Critical Habitat?
Upper Columbia River spring-run Chinook salmon (*Oncorhynchus tshawytscha*)	Endangered	Yes	No	Yes	No
Upper Columbia River steelhead (*O. mykiss*)	Threatened	Yes	No	Yes	No
Middle Columbia River steelhead (*O. mykiss*)	Threatened	Yes	No	Yes	No
Snake River sockeye salmon (*O. nerka*)	Endangered	Yes	No	Yes	No
Snake River spring/summer-run Chinook salmon (*O. tshawytscha*)	Threatened	Yes	No	Yes	No
Snake River fall-run Chinook salmon (*O. tshawytscha*)	Threatened	Yes	No	Yes	No
Snake River Basin steelhead (*O. mykiss*)	Threatened	Yes	No	Yes	No

Fishery Management Plan That Identifies EFH in the Project Area	Does Action Have an Adverse Effect on EFH?	Are EFH Conservation Recommendations Provided?
Pacific Coast Salmon	Yes	Yes

Consultation Conducted By: National Marine Fisheries Service, West Coast Region

Issued By: 

Michael Tehan
Assistant Regional Administrator
Interior Columbia Basin Office
NOAA Fisheries, West Coast Region

Date: May 12, 2020

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ACRONYM GLOSSARY

A&P	Abundance and Productivity
BA	Biological Assessment
BMP	Best Management Practice
BRT	Biological Review Team
cfs	Cubic Feet per Second
CH	Critical Habitat
CHART	Critical Habitat Analytical Review Team
Corps	U.S. Corps of Engineers
CRS	Columbia River System
cu yd	Cubic Yard
dB	Decibel
DEQ	Idaho Department of Environmental Quality
DPS	Distinct Population Segment
DQA	Data Quality Act
EFH	Essential Fish Habitat
ESA	Endangered Species Act
ESU	Evolutionarily Significant Unit
FR	Federal Register
HUC	Hydrologic Unit Code
ICRD	Interior Columbia Recovery Domain
ICTRT	Interior Columbia Basin Technical Recovery Team
IPCC	Intergovernmental Panel on Climate Change
ISAB	Independent Scientific Advisory Board
ITS	Incidental Take Statement
MCR	Middle Columbia River
MPG	Major Population Group
MSA	Magnuson–Stevens Fishery Conservation and Management Act
NMFS	National Marine Fisheries Service
NWFSC	Northwest Fisheries Science Center
ODEQ	Oregon Department of Environmental Quality
OHWM	Ordinary High Water Mark
opinion	Biological Opinion
PAH	Polycyclic Aromatic Hydrocarbon
PBF	Physical or Biological Features
PCE	Primary Constituent Element
PFMC	Pacific Fishery Management Council
Project	AgriNorthwest Intake Screen Replacement Project
RMS	Root Mean Square
RPM	Reasonable and Prudent Measure
SEL	Sound Exposure Level
SPCC	Spill Prevention, Containment, and Control
SR	Snake River
SRB	Snake River Basin
SS/D	Spatial Structure and Diversity
TSS	Total Suspended Solids

UCR	Upper Columbia River
UCSRB	Upper Columbia Salmon Recovery Board
USDC	United States Department of Commerce
VSP	Viable Salmonid Population

1. INTRODUCTION

This Introduction section provides information relevant to the other sections of this document and is incorporated by reference into Sections 2 and 3, below.

1.1. Background

The National Marine Fisheries Service (NMFS) prepared the biological opinion (opinion) and incidental take statement (ITS) portions of this document in accordance with section 7(b) of the Endangered Species Act (ESA) of 1973 (16 USC 1531 et seq.), and implementing regulations at 50 CFR 402, as amended.

We also completed an essential fish habitat (EFH) consultation on the proposed action, in accordance with section 305(b)(2) of the Magnuson–Stevens Fishery Conservation and Management Act (MSA) (16 U.S.C. 1801 et seq.) and implementing regulations at 50 CFR 600.

We completed pre-dissemination review of this document using standards for utility, integrity, and objectivity in compliance with applicable guidelines issued under the Data Quality Act (DQA) (section 515 of the Treasury and General Government Appropriations Act for Fiscal Year 2001, Public Law 106-554). The document will be available within 2 weeks at the NOAA Library Institutional Repository [https://repository.library.noaa.gov/welcome]. A complete record of this consultation is on file at NMFS' La Grande office.

1.2. Consultation History

NMFS received a letter requesting informal consultation along with a biological assessment (BA) from the U.S. Army Corps of Engineers (Corps) on December 9, 2019.

The Corps concluded that the proposed action is not likely to adversely affect Upper Columbia River (UCR) spring-run Chinook salmon (*Oncorhynchus tshawytscha*), Snake River (SR) spring/summer-run Chinook salmon, UCR steelhead (*O. mykiss*), Middle Columbia River (MCR) steelhead, Snake River Basin (SRB) steelhead, SR fall-run Chinook salmon (*O. tshawytscha*), SR sockeye salmon (*O. nerka*), and designated critical habitat for these seven species. The Corps also concluded that EFH for Chinook salmon and coho salmon, as designated by Section 305 of the Magnuson-Stevens Fishery Conservation and Management Act, is not likely to be adversely affected.

On December 17, 2019, NMFS requested additional information from the Corps regarding the equipment that will be used to install the micropiles and intake screens, the floating barge that will be used to deploy heavy equipment, existing instream habitat in the project area, the location of staging, storage, and vehicle fueling; and whether or not turbidity monitoring and containment will occur. The requested information was provided by Gary Weatherly (J-U-B Engineers) via email on December 31, 2019.

Additional information was requested via email on January 21 and 22, 2020, regarding micropile and sheet wall installation, anticipated duration of vibratory hammer use and drilling, and how

sediment will be removed from inside the pump station. The requested information was provided by Gary Weatherly on January 27 and February 4, 2020.

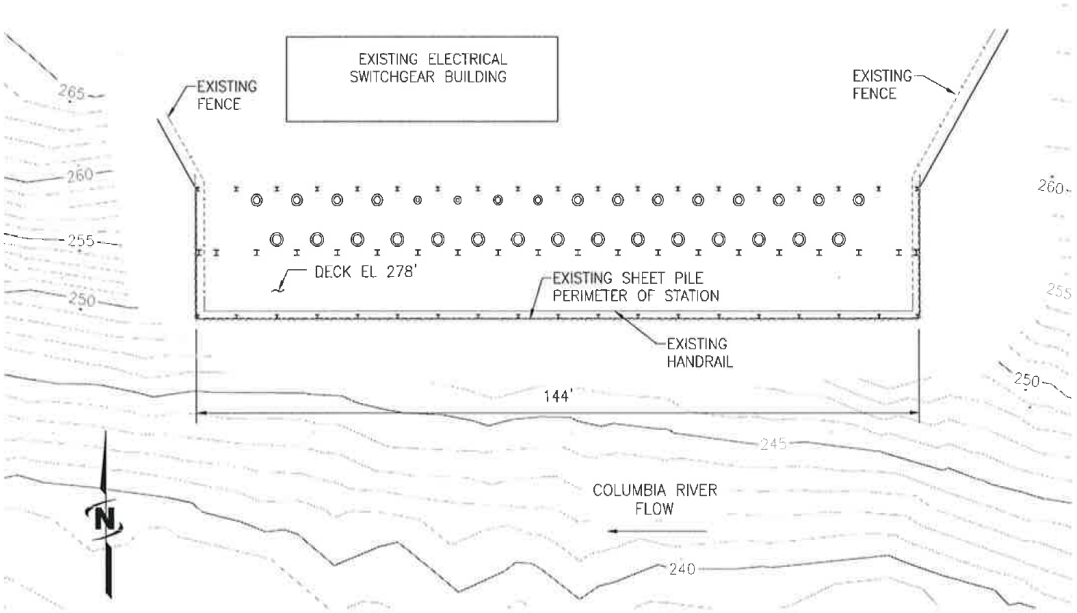
On February 18, 2020, NMFS provided the Corps NMFS' 30-day letter regarding completeness of the initiation package. NMFS did not agree with the Corps' determinations of may affect, not likely to adversely affect for UCR spring-run Chinook salmon, UCR steelhead, MCR steelhead, SR spring/summer-run Chinook salmon, SRB steelhead, SR fall-run Chinook salmon and SR sockeye, and, therefore, initiated formal consultation. Consultation was initiated on January 2, 2020.

1.3. Proposed Federal Action

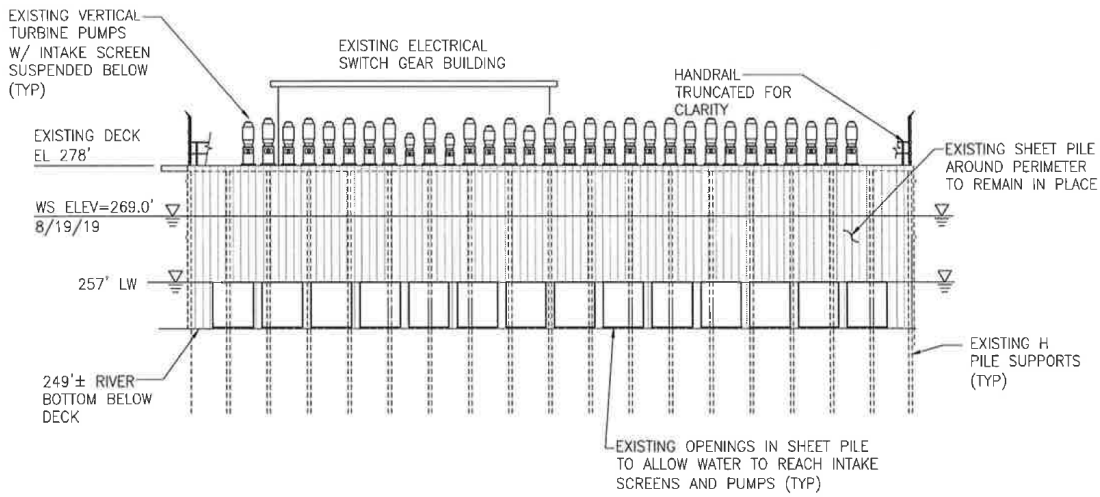
"Action" means all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by federal agencies (50 CFR 402.02). For the purpose of EFH consultation, a federal action means any action authorized, funded, or undertaken, or proposed to be authorized, funded, or undertaken by a federal agency (50 CFR 600.910).

The Corps is evaluating an application from AgriNorthwest, Inc. for removal of individual barrel screens and replacement with new intake pipes and screens. AgriNorthwest proposes to replace water intake screens at its pump station on the Columbia River, 4.2 miles south of Plymouth, Washington, with new intake pipes and screens that meet current water withdrawal fish screen design criteria as established by NMFS. The proposed project includes replacing the existing screens beneath the pump station deck with 11 48-inch-diameter stainless steel wedge wire tee intake screens, installed approximately 35 feet outside of and in front of the pump station. The proposed work will occur during the in-water work window, January 1 through February 28, 2021. The Corps' authorities for permitting this action are derived from Section 10 of the Rivers and Harbors Act (33 U.S.C. 403) and Section 404 of the Clean Water Act (33 U.S.C. 1344).

The pump station consists of a sheet pile barrier, which begins at the shoreline and extends approximately 100 feet into the river channel. The sheet pile barrier on the face of the pump station is about 144 feet wide (Figure 1). Some sections of sheet pile were partially removed, previously, to improve flow across the interior barrel screens, including windows cut out on the upstream and streamward side of the structure, and a large section was removed on the downstream side of the structure. The existing openings in the sheet pile wall will be sealed by installing 200 linear feet of a new straight sheet pile wall immediately adjacent to and outside the existing wall. The straight sheet pile wall will be installed around the perimeter of the existing station using either a barge-mounted or shore-based crane. The sheet pile will be driven with a vibratory hammer to approximately 5 feet deep, just enough to seal the bottom, and then be bolted to the existing pile. Cumulative daily duration of peak underwater noise from pile-driving is anticipated to be up to 32 hours, and work is expected to take 4 days. Pile driving operations will only be completed during the day. Holes will be cut in the new sheet pile as required to install the new 60 inch diameter intake pipes.



PLAN



FRONT VIEW

30-07-045 CORP.DWG

PURPOSE: REPLACE/IMPROVE INTAKE SCREENS	EXISTING RIVER STATION	IN: COLUMBIA RIVER
OWNER: AGRINORTHWEST, INC. P.O. BOX 2308 KENNEWICK, WASH 99336	0 15 30 SCALE IN FEET	AT: RIVER MILE 284.5± COUNTY OF: BENTON STATE: WASHINGTON
ADJACENT PROPERTY OWNERS: 1. ARMY CORPS OF ENGINEERS 2. BURLINGTON NORTHERN RAILROAD	LAT/LONG: LAT: 45.922415 LONG: -119.435028 SHEET 2 OF 6	LOCATION: NW¼ NW¼, SECTION 15, TOWNSHIP 5 NORTH, RANGE 27 EAST, WM. DATE 10/25/19

Figure 1. Existing AgriNorthwest pump station in the John Day Reservoir.

After the sheet pile is installed, approximately 158 cubic yards (cu yd) of sediment and debris that has accumulated inside the structure will be removed and a concrete floor will be placed on the river bottom inside the sheet pile wall. The sediment and debris will be hydraulically pumped or bucketed out of the screen openings in the deck to trucks or a barge and disposed of at an upland location. The existing screens will be removed through openings in the existing deck using a shore-based crane.

The sheet pile wall will serve as a turbidity curtain and as a form for the concrete bottom. Concrete placed inside the sheet pile wall will be pumped into place from a shore-based truck. Approximately 158 cu yd of concrete will be tremied into place beneath the existing structure.

The pump station is currently open to the river, and fish can freely swim inside the structure. The newly installed sheet pile wall will close off the interior of the structure from the river and could potentially result in fish entrapment. Prior to the structure being sealed off from the river, divers will inspect the interior of the structure to ensure that no salmonids are present. If fish are detected, they will be driven out of the openings in the structure using moving curtains; this will not include direct capture or handling of fish.

The sheet pile wall will have flanged connections for 11 60-inch-diameter pipes. Until the pipes are actually installed, the flanges will be blind-flanged off to retain turbid water and keep fish from entering the work area.

Eleven 48-inch-diameter stainless steel wedge wire tee intake screens will be installed in front of the new sheet pile wall, outside the structure (Figure 2). These screens will meet the current NMFS slot opening standard of 0.069 inches, and have a maximum approach velocity of 0.4 feet per second and a net open area above 50 percent. The new screens will include baffling to generate more uniform flows across the entire screen surface area, which will reduce plugging. They will be connected via new 60-inch-diameter intake pipes that penetrate the sheet pile wall. The steel pipes will rest on the river bottom or be supported slightly above the bottom.

Each of the new intake pipes and screens will be supported by 8-inch-diameter micropiles, four per screen/pipe assembly for support and anchoring (44 total). The micropiles will be drilled into the river bottom using barge mounted equipment, and will displace about 9 cu yd of material from the holes with a cement grout contained in a steel pipe that will extend about 3 feet above the river bottom.

The new screens and intake piping will extend 27 to 35 feet beyond the current face of the pump station, following the existing slope of the river bottom. The screens will include an automated air burst cleaning system to prevent debris buildup.

Following installation of the micropiles, individual blind flanges will be removed and the pipe/screen assemblies bolted to the flanged connections on the sheet pile perimeter wall. The intake pipes will rest on the river bottom or be supported slightly above it. The tee screens will be mounted to the top of the pipe, providing one screen diameter submergence of the screens at minimum pool level (257 feet).

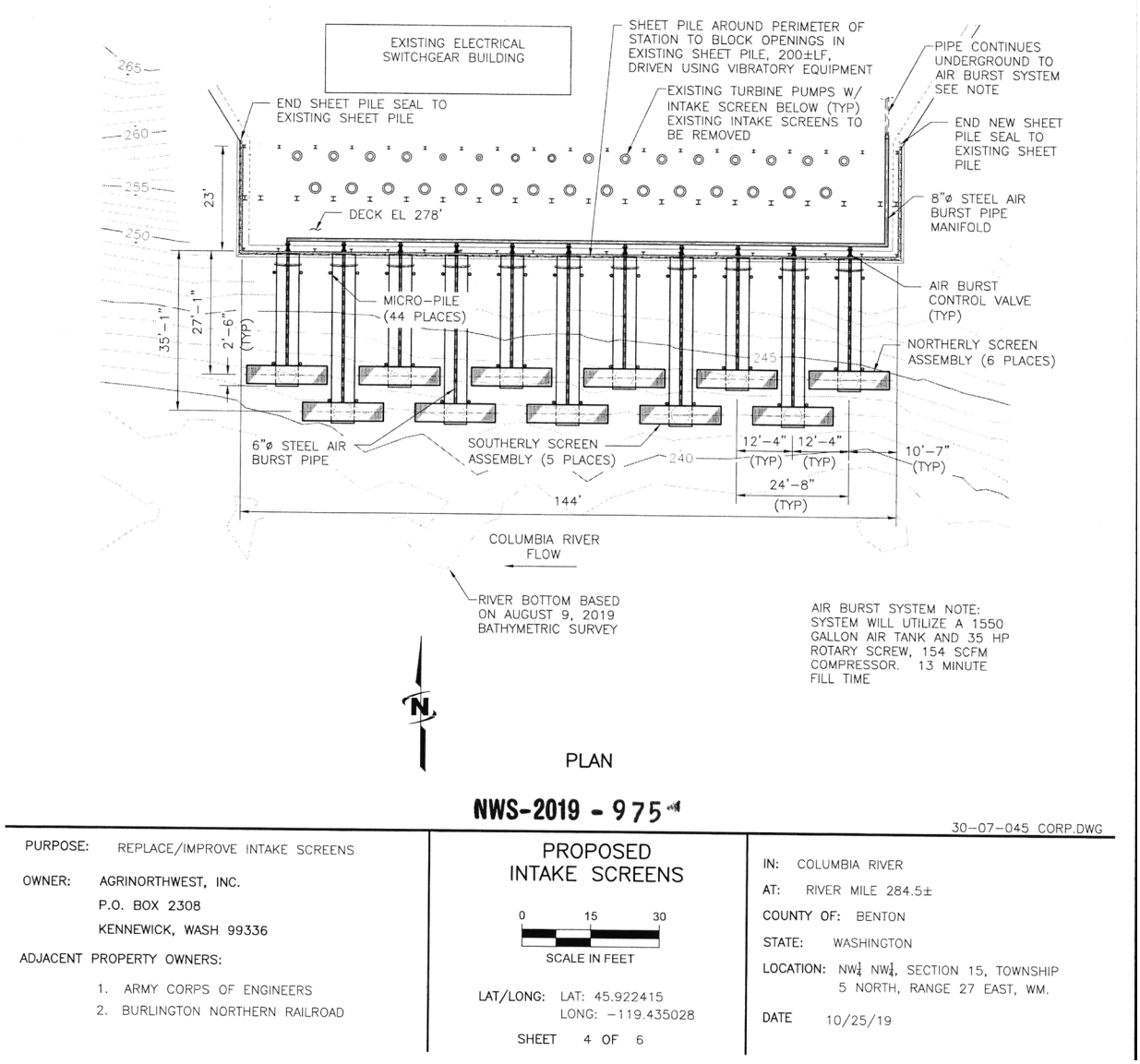


Figure 2. Proposed intake screens for the AgriNorthwest irrigation pump station in the John Day Reservoir.

The project will include the use of some heavy equipment deployed on either the structure deck or a floating barge, including: drilling and grouting equipment, an excavator, a cement truck and a crane. Construction equipment used for the project will be operated during daylight hours only. The barge, approximately 40 feet wide by 70 feet long, will be in place for 8 weeks.

Hard materials for the project will be stockpiled in the graveled areas located both inside and outside the pump station security fence. Fuel and liquids will not be stored at the site. A fuel/maintenance truck will come to the site and fill up equipment in the gravel area. Fueling will occur outside the security fence where it will be 50 to 60 feet from the shoreline. The contractor will develop and implement a site-specific spill prevention, containment, and control (SPCC)

plan for the project and will be responsible for containment and removal of any releases. The contractor will make the SPCC plan available for review by the Corps and NMFS. Equipment used in water and/or along the shoreline will be high-pressure cleaned prior to use on the project, checked for leaks, and will have oils and hydraulic fluids replaced with biodegradable fluids and oils. The contractor and applicant will allow monitoring of the site by the Corps and NMFS during construction activities.

There will be no changes to water rights or increases in water withdrawal associated with the project.

We considered whether or not the proposed action would cause any other activities and determined that it would not.

2. ENDANGERED SPECIES ACT: BIOLOGICAL OPINION AND INCIDENTAL TAKE STATEMENT

The ESA establishes a national program for conserving threatened and endangered species of fish, wildlife, plants, and the habitat upon which they depend. As required by section 7(a)(2) of the ESA, each federal agency must ensure that its actions are not likely to jeopardize the continued existence of endangered or threatened species, or adversely modify or destroy their designated critical habitat. Per the requirements of the ESA, federal action agencies consult with NMFS and section 7(b)(3) requires that, at the conclusion of consultation, NMFS provide an opinion stating how the agency's actions would affect listed species and their critical habitats. If incidental take is reasonably certain to occur, section 7(b)(4) requires NMFS to provide an ITS that specifies the impact of any incidental taking and includes non-discretionary reasonable and prudent measures (RPMs) and terms and conditions to minimize such impacts.

2.1. Analytical Approach

This opinion includes both a jeopardy analysis and an adverse modification analysis. The jeopardy analysis relies upon the regulatory definition of "jeopardize the continued existence of" a listed species, which is "to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species" (50 CFR402.02). Therefore, the jeopardy analysis considers both survival and recovery of the species.

This opinion relies on the definition of "destruction or adverse modification," which "means a direct or indirect alteration that appreciably diminishes the value of critical habitat as a whole for the conservation of a listed species" (50 CFR 402.02).

The designations of critical habitat use the term primary constituent element (PCE) or essential features. The 2016 critical habitat regulations (50 CFR 424.12) replaced this term with physical or biological features (PBFs). The shift in terminology does not change the approach used in conducting a "destruction or adverse modification" analysis, which is the same regardless of whether the original designation identified PCEs, PBFs, or essential features. In this opinion, we use the term PBF to mean PCE or essential feature, as appropriate for the specific critical habitat.

The 2019 regulations define effects of the action using the term "consequences" (50 CFR 402.02). As explained in the preamble to the regulations (84 FR 44977), that definition does not change the scope of our analysis and in this opinion we use the terms "effects" and "consequences" interchangeably.

We use the following approach to determine whether a proposed action is likely to jeopardize listed species or destroy or adversely modify critical habitat:

- Evaluate the rangewide status of the species and critical habitat expected to be adversely affected by the proposed action.
- Evaluate the environmental baseline of the species and critical habitat.
- Evaluate the effects of the proposed action on species and their habitat using an exposure-response approach.
- Evaluate cumulative effects.
- In the integration and synthesis, add the effects of the action and cumulative effects to the environmental baseline, and, in light of the status of the species and critical habitat, analyze whether the proposed action is likely to: (1) directly or indirectly reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species, or (2) directly or indirectly result in an alteration that appreciably diminishes the value of critical habitat as a whole for the conservation of a listed species.
- If necessary, suggest a reasonable and prudent alternative to the proposed action.

2.2. Rangewide Status of the Species and Critical Habitat

In this opinion we examine the status of each species that would be adversely affected by the proposed action. The status is determined by the level of extinction risk that the listed species face, based on parameters considered in documents such as recovery plans, status reviews, and listing decisions. This informs the description of the species' likelihood of both survival and recovery. The species status section also helps to inform the description of the species' "reproduction, numbers, or distribution" as described in 50 CFR 402.02. The opinion also examines the condition of critical habitat throughout the designated area, evaluates the conservation value of the various watersheds and coastal and marine environments that make up the designated area, and discusses the function of the essential PBFs that help to form that conservation value.

One factor affecting the status of ESA-listed species considered in this opinion, and aquatic habitat at large, is climate change. Climate change is likely to play an increasingly important role in determining the abundance and distribution of ESA-listed species, and the conservation value of its designated critical habitats, in the Pacific Northwest. These changes will not be spatially homogeneous across the Pacific Northwest. The largest hydrologic responses are expected to occur in basins with significant snow accumulation, where warming decreases snow pack, increases winter flows, and advances the timing of spring melt (Mote et al. 2014, 2016). Rain-dominated watersheds and those with significant contributions from groundwater may be less sensitive to predicted changes in climate (Tague et al. 2013; Mote et al. 2014).

During the last century, average regional air temperatures in the Pacific Northwest increased by 1 to 1.4°F as an annual average, and up to 2°F in some seasons, based on average linear increase per decade (Abatzoglou et al. 2014; Kunkel et al. 2013). Warming is likely to continue during the next century as average temperatures are projected to increase another 3 to 10°F, with the largest increases predicted to occur in the summer (Mote et al. 2014).

Decreases in summer precipitation of as much as 30 percent by the end of the century are consistently predicted across climate models (Mote et al. 2014). Precipitation is more likely to occur during October through March, less during summer months, and more winter precipitation will be rain than snow (ISAB 2007; Mote et al. 2014). Earlier snowmelt will cause lower stream flows in late spring, summer, and fall, and water temperatures will be warmer (ISAB 2007; Mote et al. 2014). Models consistently predict increases in the frequency of severe winter precipitation events (i.e., 20-year and 50-year events), in the western United States (Dominguez et al. 2012). The largest increases in winter flood frequency and magnitude are predicted in mixed rain-snow watersheds (Mote et al. 2014).

Overall, about one-third of the current cold-water salmonid habitat in the Pacific Northwest is likely to exceed key water temperature thresholds by the end of this century (Mantua et al. 2009). Higher temperatures will reduce the quality of available salmonid habitat for most freshwater life stages (ISAB 2007). Reduced flows will make it more difficult for migrating fish to pass physical and thermal obstructions, limiting their access to available habitat (Mantua et al. 2010). Temperature increases shift timing of key life cycle events for salmonids and species forming the base of their aquatic foodwebs (Crozier et al. 2011; Tillmann and Siemann 2011; Winder and Schindler 2004). Higher stream temperatures will also cause decreases in dissolved oxygen and may also cause earlier onset of stratification and reduced mixing between layers in lakes and reservoirs, which can also result in reduced oxygen (Meyer et al. 1999; Winder and Schindler 2004). Higher temperatures are likely to cause several species to become more susceptible to parasites, disease, and higher predation rates (Crozier et al. 2008; Wainwright and Weitkamp 2013).

As more basins become rain-dominated and prone to more severe winter storms, higher winter stream flows may increase the risk that winter or spring floods in sensitive watersheds will damage spawning redds and wash away incubating eggs (Goode et al. 2013). Earlier peak stream flows will also alter migration timing for salmon smolts and may flush some young salmon and steelhead from rivers to estuaries before they are physically mature, increasing stress and reducing smolt survival (McMahon and Hartman 1989; Lawson et al. 2004).

In addition to changes in freshwater conditions, predicted changes for coastal waters in the Pacific Northwest as a result of climate change include increasing surface water temperature, increasing but highly variable acidity, and increasing storm frequency and magnitude (Mote et al. 2014). Elevated ocean temperatures already documented for the Pacific Northwest are highly likely to continue during the next century, with sea surface temperature projected to increase by 1.0 to 3.7ºC by the end of the century (IPCC 2014). Habitat loss, shifts in species' ranges and abundances, and altered marine food webs could have substantial consequences to anadromous, coastal, and marine species in the Pacific Northwest (Tillmann and Siemann 2011).

Moreover, as atmospheric carbon emissions increase, increasing levels of carbon are absorbed by the oceans, changing the pH of the water. A 38 to 109 percent increase in acidity is projected by the end of this century in all but the most stringent CO_2 mitigation scenarios, and is essentially irreversible over a time scale of centuries (IPCC 2014). Regional factors appear to be amplifying acidification in Northwest ocean waters, which is occurring earlier and more acutely than in other regions and is already impacting important local marine species (Barton et al. 2012; Feely et al. 2012). Acidification also affects sensitive estuary habitats, where organic matter and nutrient inputs further reduce pH and produce conditions more corrosive than those in offshore waters (Feely et al. 2012; Sunda and Cai 2012).

Global sea levels are expected to continue rising throughout this century, reaching likely predicted increases of 10 to 32 inches by 2081–2100 (IPCC 2014). These changes will likely result in increased erosion and more frequent and severe coastal flooding and shifts in the composition of nearshore habitats (Tillmann and Siemann 2011). Estuarine-dependent salmonids such as chum and Chinook salmon are predicted to be impacted by significant reductions in rearing habitat in some Pacific Northwest coastal areas (Glick et al. 2007). Historically, warm periods in the coastal Pacific Ocean have coincided with relatively low abundances of salmon and steelhead, while cooler ocean periods have coincided with relatively high abundances, and therefore these species are predicted to fare poorly in warming ocean conditions (Scheuerell and Williams 2005; Zabel et al. 2006). This is supported by the recent observation that anomalously warm sea surface temperatures off the coast of Washington from 2013 to 2016 resulted in poor coho and Chinook salmon body condition for juveniles caught in those waters (NWFSC 2015). Changes to estuarine and coastal conditions, as well as the timing of seasonal shifts in these habitats, have the potential to impact a wide range of listed aquatic species (Tillmann and Siemann 2011; Reeder et al. 2013).

The adaptive ability of these threatened and endangered species is depressed due to reductions in population size, habitat quantity and diversity, and loss of behavioral and genetic variation. Without these natural sources of resilience, systematic changes in local and regional climatic conditions due to anthropogenic global climate change will likely reduce long-term viability and sustainability of populations in many of these Evolutionarily Significant Units (ESUs) (NWFSC 2015). New stressors generated by climate change, or existing stressors with effects that have been amplified by climate change, may also have synergistic impacts on species and ecosystems (Doney et al. 2012). These conditions will possibly intensify the climate change stressors inhibiting recovery of ESA-listed species in the future.

2.2.1 Status of the Species

For Pacific salmon and steelhead, we commonly use the four "viable salmonid population" (VSP) criteria (McElhany et al. 2000) to assess the viability of the populations that, together, constitute the species. These four criteria (spatial structure, diversity, abundance, and productivity) encompass the species' "reproduction, numbers, or distribution" as described in 50 CFR 402.02. When these parameters are collectively at appropriate levels, they maintain a population's capacity to adapt to various environmental conditions and allow it to sustain itself in the natural environment.

Spatial structure refers both to the spatial distributions of individuals in the population and the processes that generate that distribution. A population's spatial structure depends on habitat quality and spatial configuration, and the dynamics and dispersal characteristics of individuals in the population.

Diversity refers to the distribution of traits within and among populations. These range in scale from DNA sequence variation in single genes to complex life history traits (McElhany et al. 2000).

Abundance generally refers to the number of naturally-produced adults (i.e., the progeny of naturally-spawning parents) in the natural environment (e.g., on spawning grounds).

Productivity, as applied to viability factors, refers to the entire life cycle (i.e., the number of naturally-spawning adults produced per parent). When progeny replace or exceed the number of parents, a population is stable or increasing. When progeny fail to replace the number of parents, the population is declining. McElhany et al. (2000) use the terms *population growth rate* and *productivity* interchangeably when referring to production over the entire life cycle. They also refer to *trend in abundance*, which is the manifestation of long-term population growth rate.

For species with multiple populations, once the biological status of a species' populations has been determined, we assess the status of the entire species using criteria for groups of populations, as described in recovery plans and guidance documents from technical recovery teams. Considerations for species viability include having multiple populations that are viable, ensuring that populations with unique life histories and phenotypes are viable, and that some viable populations are both widespread to avoid concurrent extinctions from mass catastrophes and spatially close to allow functioning as metapopulations (McElhany et al. 2000).

The summary that follows describes the status of seven ESA-listed species, and their designated critical habitats that occur within the geographic area of this proposed action and are considered in this opinion. More detailed information on the status and trends of these listed resources, and their biology and ecology, are in the listing regulations and critical habitat designations published in the Federal Register (Table 1), as well as applicable recovery plans and 5-year status reports. These additional documents are incorporated by reference (NMFS 2009; NMFS 2015; NMFS 2016a; NMFS 2016b; NMFS 2016c; NMFS 2017a; NMFS 2017b; UCSRB 2007). These documents are available on the NMFS West Coast Region website (http://www.westcoast.fisheries.noaa.gov/). The next 5-year status reviews will be completed in 2021.

Table 1. Listing status, status of critical habitat designations and protective regulations, and relevant Federal Register (FR) decision notices for ESA-listed species considered in this opinion. Listing status: 'T' means listed as threatened; 'E' means listed as endangered.

Species	Listing Status	Critical Habitat	Protective Regulations
Chinook salmon *(Oncorhynchus tshawytscha)*			
Upper Columbia River spring-run	E 6/28/05; 70 FR 37160	9/02/05; 70 FR 52630	ESA section 9 applies
Snake River spring/summer-run	T 6/28/05; 70 FR 37160	10/25/99; 64 FR 57399	6/28/05; 70 FR 37160
Snake River fall-run	T 6/28/05; 70 FR 37160	12/28/93; 58 FR 68543	6/28/05; 70 FR 37160
Sockeye salmon *(O. nerka)*			
Snake River	E 8/15/11; 70 FR 37160	12/28/93; 58 FR 68543	ESA section 9 applies
Steelhead (*O. mykiss*)			
Middle Columbia River	T 1/5/06; 71 FR 834	9/02/05; 70 FR 52630	6/28/05; 70 FR 37160
Upper Columbia River	T 1/5/06; 71 FR 834	9/02/05; 70 FR 52630	2/1/06; 71 FR 5178
Snake River Basin	T 1/5/06; 71 FR 834	9/02/05; 70 FR 52630	6/28/05; 70 FR 37160

Upper Columbia River Spring-run Chinook Salmon ESU

The UCR spring-run Chinook salmon ESU was originally listed as endangered under the ESA in 1998 (64 FR 14308), and the status was affirmed in 2005 and 2012. In 2016, the 5-year review for UCR spring-run Chinook salmon concluded that the species should maintain its endangered listing classification (NWFSC 2015; NMFS 2016a).

A recovery plan is available for this species (UCSRB 2007). A 5-year status review was completed in 2015 (NMFS 2016a). Achieving recovery (i.e., delisting the species) of each ESU via sufficient improvement in the abundance, productivity, spatial structure, and diversity is the longer-term goal of the UCSRB Plan. The plan calls for meeting or exceeding the same basic spatial structure and diversity criteria adopted from the Interior Columbia Technical Recovery Team (ICTRT) viability report for recovery (NWFSC 2015). None of the three populations are viable with respect to A&P, and they all have a greater than 25 percent chance of extinction in 100 years (UCSRB 2007).

Spatial structure and diversity. This species includes all naturally-spawned populations of Chinook salmon in all river reaches accessible to Chinook salmon in Columbia River tributaries upstream of the Rock Island Dam and downstream of Chief Joseph Dam (excluding the Okanogan River), the Columbia River upstream to Chief Joseph Dam, and progeny of six artificial propagation programs. Historically, UCR spring-run Chinook salmon likely included three major population groups (MPG). Two of these MPGs were eliminated by the completion of Grand Coulee and Chief Joseph Dams (UCSRB 2007; NWFSC 2015). The North Cascades MPG is comprised of three extant populations: the Wenatchee River, the Methow River, and the Entiat River populations.

The composite spatial structure and diversity (SS/D) risks for all three of the extant natural populations in this MPG are rated at high risk (Table 2). The natural processes component of the SS/D risk is low for the Wenatchee River and Methow River populations and moderate for the Entiat River population. All three of the extant populations in this ESU are rated at high risk for diversity, driven primarily by chronically high proportions of hatchery-origin spawners (26 to 76

percent) in natural spawning areas and a lack of genetic diversity among the natural-origin spawners (ICTRT 2007; NWFSC 2015). This effect is particularly high in the Wenatchee and Methow populations with hatchery spawners composing 66 percent and 76 percent, respectively (NMFS 2014). The high proportion of hatchery spawners reflects the large increase in releases from the directed supplementation programs in those two drainages. The hatchery supplementation program in the Entiat was discontinued in 2007 and hatchery fish on the spawning grounds in the Entiat have declined in recent years.

Abundance and productivity. Overall A&P remains rated at high risk for each of the three extant populations in this MPG/ESU (Table 2) (NWFSC 2015; NMFS 2016a). The recent 10-year (2009 to 2018) geometric mean abundance of adult natural-origin spawners has increased for each population relative to the levels reported in the 2011 and 2015 status reviews, and has increased for two of the three populations relative to the levels for the 1999 to 2008 series. But, natural origin escapements remain below the corresponding ICTRT thresholds. Estimated productivity (returns-per-spawner) was on average about the same in 2009–2018 as in 1999 to 2008, and indicates that UCR spring-run Chinook salmon populations are not replacing themselves. Increases in natural origin abundance relative to the extremely low spawning levels observed in the mid-1990s are encouraging; however, average productivity levels remain extremely low. Possible contributing factors include density dependent effects, differences in spawning distribution relative to habitat quality, and reduced fitness of hatchery-origin spawners. Overall, the combinations of current A&P for each population result in a high risk rating when compared to the ICTRT viability curves (NWFSC 2015).

Table 2. Upper Columbia River Spring-run Chinook Salmon ESU population viability status summary.

Population	Abundance and productivity metrics*				Spatial structure and diversity metrics			Overall viability rating
	ICTRT minimum threshold	Natural Spawning Abundance	ICTRT Productivity	Integrated A&P Risk	Natural Processes Risk	Diversity Risk	Integrated SS/D Risk	
Wenatchee River 2005–2014	2,000	545 ↑ (311–1,030)	0.60 ↑ (0.27,15/20)	High	Low	High	High	High Risk
Entiat River 2005–2014	500	166 ↑ (78–354)	0.94 ↑ (0.18, 12/20)	High	Moderate	High	High	High Risk
Methow River 2005–2014	2,000	379 ↑ (189–929)	0.46 ○ (0.31, 16/20)	High	Low	High	High	High Risk

* Current A&P estimates are geometric means. The range in annual abundance, standard error, and number of qualifying estimates for production are in parentheses. Upward arrows = current estimates increased from prior review. Oval = no change since prior review (NWFSC 2015). The Wenatchee, Entiat, and Methow River populations are considered a high risk for both A&P and composite spatial structure and diversity (SS/D), as they are noted in the above table.

Limiting factors. Limiting factors include (UCSRB 2007):

- Effects related to hydropower system in the mainstem Columbia River, including reduced upstream and downstream fish passage, altered ecosystem structure and function, altered flows, and degraded water quality
- Degradation of floodplain connectivity and function, channel structure and complexity, riparian areas and large woody debris recruitment, stream flow, and water quality
- Degraded estuarine and nearshore marine habitat
- Hatchery-related effects
- Persistence of non-native (exotic) fish species continues to affect habitat conditions for listed species
- Harvest in Columbia River fisheries

Snake River Spring/Summer-run Chinook Salmon ESU

On June 3, 1992, NMFS listed the Snake River spring/summer-run Chinook salmon ESU as a threatened species (57 FR 23458). The threatened status was reaffirmed on June 28, 2005 (70 FR 37160), and again on April 14, 2014 (79 FR 20802). NMFS released a final recovery plan for this species in October of 2017 (NMFS 2017a), and the most recent status review was completed in 2015 (NMFS 2016b). This species includes all naturally-spawned populations of spring/summer-run Chinook salmon originating from the mainstem Snake River and the Tucannon River, Grande Ronde River, Imnaha River, and Salmon River subbasins, and from 10 artificial propagation programs (USDC 2014). The ICTRT recognized 28 extant and three extirpated populations of SR spring/summer-run Chinook salmon, and aggregated these into five MPGs that correspond to ecological subregions (Table 3) (ICTRT 2003; McClure et al. 2005). All but one extant population (Chamberlain Creek) are at "high" risk of extinction (NWFSC 2015).

Spatial structure and diversity. Spatial structure ratings remain unchanged or stable with low or moderate risk levels for the majority of the populations in the ESU. Four populations from three MPGs (Catherine Creek and Upper Grande Ronde of the Grande Ronde/Imnaha River MPG, Lemhi River of the Upper Salmon River MPG, and Lower Middle Fork Salmon of the Middle Fork Salmon River MPG) remain at high risk for spatial structure loss. Three MPGs in this ESU have populations that are undergoing active supplementation with local broodstock hatchery programs. In most cases, those programs evolved from mitigation efforts and include some form of sliding-scale management guidelines that limit hatchery contribution to natural spawning based on the abundance of natural-origin fish returning to spawn—the more natural-origin fish that return, the fewer hatchery fish that are needed to spawn naturally. Sliding-scale management is designed to maximize hatchery benefits in low abundance years and reduce hatchery risks at higher spawning levels.

Table 3. Major population groups, populations, and scores for the key elements of A&P, diversity, and spatial structure and diversity (SS/D), used to determine current overall viability risk for Snake River spring/summer-run Chinook salmon (NWFSC 2015). Risk ratings included very low (VL), low (L), moderate (M), high (H), very high (VH), and extirpated (E). Maintained (MT) population status indicates that the population does not meet the criteria for a viable population but does support ecological functions and preserve options for recovery of the Distinct Population Segment (DPS).

Major Population Groups	Spawning Populations (Watershed)	A&P	Natural Processes Risk	Diversity	Integrated SS/D	Overall Viability Risk
Lower Snake River	Tucannon River	H	L	M	M	H
	Asotin River	N/A	N/A	N/A	N/A	E
Grande Ronde and Imnaha rivers	Wenaha River	H	L	M	M	H
	Lostine/Wallowa River	H	L	M	M	H
	Minam River	H	L	M	M	H
	Catherine Creek	H	M	M	M	H
	Upper Grande Ronde R.	H	H	M	H	H
	Imnaha River	H	L	M	M	H
	Lookingglass Creek	N/A	N/A	N/A	N/A	E
South Fork Salmon River	Little Salmon River	*	L	L	L	H
	South Fork mainstem	H	L	M	M	H
	Secesh River	H	L	L	L	H
	EF/Johnson Creek	H	L	L	L	H
Middle Fork Salmon River	Chamberlin Creek	M	L	L	L	MT
	Big Creek	H	VL	M	M	H
	Lower Mainstem MF	*	M	M	M	H
	Camas Creek	H	L	M	M	H
	Loon Creek	H	L	M	M	H
	Upper Mainstem MF	H	L	M	M	H
	Sulphur Creek	H	L	M	M	H
	Bear Valley Creek	H	VL	L	L	H
	Marsh Creek	H	L	L	L	H
Upper Salmon River	Salmon Lower Main	H	L	L	L	H
	Salmon Upper Main	H (M)	L	L	L	H
	Lemhi River	H	H	H	H	H
	Pahsimeroi River	H (M)	M	H	H	H
	Salmon East Fork	H	L	H	H	H
	Yankee Fork	H	M	H	H	H
	Valley Creek	H	L	M	M	H
	North Fork	*	L	L	L	H
	Panther Creek	N/A	N/A	N/A	N/A	E

*Insufficient data

Abundance and productivity. Most populations will need to see increases in A&P in order for the ESU to recover. Several populations have a high proportion of hatchery-origin spawners; particularly in the Grande Ronde, Lower Snake, and South Fork Salmon MPGs. Diversity risk will also need to be lowered in multiple populations in order for the ESU to recover (NWFSC 2015). Overall, adult returns have remained very low over the past 3 years, and the trend for the recent 5 years (2014–2018) has been generally downward (ODFW and WDFW 2020). The SR

spring/summer-run Chinook salmon ESU remains at high overall risk, with the exception of one population (Chamberlain Creek in the Middle Fork Salmon River MPG.

Limiting factors. Limiting factors for this species include:

- Degradation of floodplain connectivity and function, channel structure and complexity, riparian areas and large woody debris recruitment, stream flow, and water quality.
- Effects related to the hydropower system in the mainstem Columbia River, including reduced upstream and downstream fish passage, altered ecosystem structure and function, altered flows, and degraded water quality
- Harvest-related effects
- Predation

Snake River Fall-run Chinook Salmon ESU

Snake River fall Chinook salmon were originally listed as threatened in 1992 (57 FR 14653**)**. The status was affirmed in 2005 and updated in 2014. NMFS released a final recovery plan for this species in November 2017 (NMFS 2017b). A 5-year status review was completed in 2015 (NMFS 2016b). This species includes all naturally-spawned populations of fall-run Chinook salmon originating from the mainstem Snake River below Hells Canyon Dam; from the Tucannon River, Grande Ronde River, Imnaha River, Salmon River, and Clearwater River subbasins; and from four artificial propagation programs (USDC 2014).

The ICTRT identified three populations of this species, although only the lower mainstem population exists at present, and it spawns in the lower mainstem of the Clearwater, Imnaha, Grande Ronde, Salmon and Tucannon rivers. The extant population of SR fall-run Chinook salmon is the only remaining population from a historical ESU that also included large mainstem populations upstream of the current location of the Hells Canyon Dam complex (ICTRT 2003; McClure et al. 2005). The extant population has a high proportion of hatchery-origin spawners.

Updated biological risk summary. Overall population viability for the Lower Mainstem SR fall-run Chinook salmon population is determined based on the combination of ratings for current A&P and combined SS/D (Table 4). More detailed information on the status and trends of these listed resources and their biology and ecology are in status updates (NWFSC 2015; NMFS 2016b).

Table 4. Lower Mainstem Snake River fall-run Chinook salmon population risk ratings integrated across the four viable salmonid population metrics. Viability Key: HV–Highly Viable; V–Viable; M–Maintained; HR–High Risk; Green shaded cells–meets criteria for Highly Viable; Gray shaded cells–does not meet viability criteria (darkest cells are at greatest risk).

Population Risk Ratings	Very Low	Low	Moderate	High
Very Low (<1%)	HV	HV	V	M
Low (1–5%)	V	V	V Lower Mainstem Snake	M
Moderate (6–25%)	M	M	M	HR
High (>25%)	HR	HR	HR	HR

Based on substantial improvements in the A&P of the ESU, the most recent 5-year status review (NMFS 2016b) recommended that the overall risk rating for SR fall Chinook salmon be reduced from moderate risk (i.e., maintained) to low risk (i.e., viable), based on a low risk rating for A&P and a moderate risk rating for SS/D. NMFS (2016b) gave the ESU a rating of moderate risk for SS/D, "driven by changes in major life history patterns, shifts in phenotypic traits, and high levels of genetic homogeneity in samples from natural-origin returns." The rating also reflected risk associated with the high levels of hatchery-origin spawners in natural spawning areas and "the potential for selective pressure imposed by current hydropower operations and cumulative harvest impacts."

Overall, the abundance of SR fall Chinook salmon (including natural-origin fish) has increased substantially in recent years. However, from 2015 through 2019, annual returns steadily decreased and natural-origin and hatchery-origin returns in 2019 were below the recent 10-year average. The population is considered viable, but will need to see an increase in productivity combined with a reduction in diversity risk for the ESU to recover (ICTRT 2010; NWFSC 2015).

Limiting factors. Limiting factors for this species include:

- Degradation of floodplain connectivity and function and channel structure and complexity
- Harvest-related effects
- Loss of access to historical habitat above Hells Canyon and other Snake River dams
- Impacts from mainstem Columbia River and Snake River hydropower systems
- Hatchery-related effects
- Degraded estuarine and nearshore habitat

Snake River Sockeye Salmon ESU

The SR sockeye salmon were ESA-listed in November 1991 (56 FR 58619) as endangered. We reaffirmed the listing in 2005 (70 FR 2853). Best available information indicates that the SR Sockeye salmon ESU is at high risk and remains at endangered status. We released a final recovery plan for this species on June 8, 2015 (NMFS 2015). The most recent 5-year status review was completed in 2015 (NMFS 2016b). Overall, the recovery strategy aims to reintroduce

and support adaptation of naturally self-sustaining sockeye salmon populations in the Sawtooth Valley lakes.

Spatial structure and diversity. This species includes all anadromous and residual sockeye salmon from the SR Basin, Idaho, and artificially-propagated sockeye salmon from the Redfish Lake Captive Broodstock Program. The ICTRT defined Sawtooth Valley Sockeye salmon as the single MPG within the SR Sockeye Salmon ESU. The MPG contains one extant population (Redfish Lake) and two to four historical populations (Alturas, Petit, Stanley, and Yellowbelly lakes) (NMFS 2015). At the time of listing in 1991, the only confirmed extant population included in this ESU was the beach-spawning population of sockeye salmon from Redfish Lake, with about 10 fish returning per year (NMFS 2015).

Abundance and productivity. The average annual return to the Sawtooth Basin near Stanley, Idaho from 2009–2018 was 635 adults, ranging from a low of 91 adults in 2015 (including 35 transported from Lower Granite Dam) to 1, 579 adults in 2014 (including 453 natural-origin fish). Sockeye salmon returns to Alturas Lake ranged from one fish in 2002 to 14 fish in 2010. No fish returned to Alturas Lake in 2012, 2013, or 2014 (NMFS 2015). Although total sockeye salmon returns to the Sawtooth Valley in recent years have been high enough to allow for some level of natural spawning in Redfish Lake, the hatchery program remains at its initial phase with a priority on genetic conservation and building sufficient returns to support sustained outplanting and recolonization of the species' historic range (NMFS 2015; NWFSC 2015).

The recent 10-year average return to the Columbia River for Snake River sockeye is 1,275. Adult returns of sockeye salmon to the Sawtooth Basin showed a general pattern of increase through 2014. In 2015, elevated water temperatures resulted in only 1 percent survival from Bonneville to Lower Granite Dam. During 2015–2017, the hatcheries had operational issues that resulted in high juvenile mortalities. These contributed to the decline in adult returns from 2015–2019. The 2018 return of 297 and the 2019 return of 342 Snake River sockeye to the Columbia River mouth were less than 30 percent of the recent 10-year average. The recent 10-year average count of Snake River Basin sockeye at Lower Granite Dam is 970. Sockeye counts at Lower Granite Dam totaled only 213 fish in 2018 and 81 in 2019. Sockeye returns to the Sawtooth Valley in 2018 and 2019 are an estimated 113 and 17, respectively.

Limiting factors. The key factor limiting recovery of the SR sockeye salmon ESU is survival outside of the Stanley Basin. Portions of the migration corridor in the Salmon River are impaired by reduced water quality and elevated temperatures (DEQ 2011). The natural hydrological regime in the upper mainstem Salmon River Basin has been altered by water withdrawals. Survival rates from Lower Granite Dam to the spawning grounds are low in some years (e.g., average of 31 percent, range of 0–67 percent for 1991–1999) (Keefer et al. 2008). Keefer et al. (2008) conducted a radio tagging study on adult SR sockeye salmon passing upstream from Lower Granite Dam in 2000 and concluded that high in-river mortalities could be explained by "a combination of high migration corridor water temperatures and poor initial fish condition or parasite loads." Keefer et al. (2008) also examined current run timing of SR sockeye salmon versus records from the early 1960s, and concluded that an apparent shift to earlier run timing recently may reflect increased mortalities for later migrating adults. In the Columbia and lower Snake River migration corridor, predation rates on juvenile sockeye salmon are unknown, but

terns and cormorants consume 12 percent of all salmon smolts reaching the estuary, and piscivorous fish consume an estimated 8 percent of migrating juvenile salmon (NMFS 2011).

Upper Columbia River Steelhead DPS

The UCR steelhead distinct population segment (DPS) was originally listed under the ESA in 1997 (62 FR 43937). The Upper Columbia Recovery Plan calls for "…restoring the distribution of naturally-produced spring-run Chinook salmon and steelhead to previously occupied areas where practical, and conserving their genetic and phenotypic diversity" (UCSRB 2007). In 2015, the 5-year review for the UCR steelhead concluded the species should maintain its threatened listing classification (NWFSC 2015; NMFS 2016a).

Spatial structure and diversity. The UCR steelhead DPS is composed of a single MPG which includes four naturally-spawned anadromous steelhead populations below natural and artificial impassable barriers in streams within the Columbia River Basin, upstream from the Yakima River, Washington, to the United States–Canada border, as well as six artificial propagation programs. Historically, there were likely three MPGs. Two additional steelhead MPGs likely spawned above Grand Coulee and Chief Joseph Dams, but these MPGs are extirpated, and reintroduction is not required for ESA recovery (UCSRB 2007). NMFS has defined the UCR steelhead DPS to include only the anadromous members of this species (70 FR 67130).

All extant natural populations are considered to be at high risk of extinction for SS/D (NWFSC 2015). With the exception of the Okanogan population, the UCR steelhead populations were rated as low risk for spatial structure. Each population is at high risk for diversity, largely driven by chronic high levels of hatchery spawners (42 to 87 percent) within natural spawning areas and lack of genetic diversity among the populations. The proportions of hatchery-origin returns in natural spawning areas remain extremely high across the DPS, especially in the Methow and Okanogan River populations.

Abundance and productivity. Both A&P characteristics remain at "high" risk for three of the four populations in this DPS (Table 5). Although UCR steelhead populations have increased in natural origin abundance in recent years, productivity levels remain low, except for the Wenatchee population. The modest improvements in natural returns in recent years are primarily the result of several years of relatively good survival in the ocean and tributary habitats, and recent downturns in abundance reflect recent poor ocean conditions. The recent 5-year average (2015–2019) of natural origin spawners in all four populations has decreased relative to the recent 10-year average (2010–2019). UCR steelhead populations have increased relative to the low levels observed in the 1990s, but natural origin A&P remain well below viability thresholds for three out of the four populations. The most recent estimates of natural-origin spawner abundance for each of the four populations in the UCR steelhead DPS show fairly consistent patterns throughout the years. None of the populations have reached their recovery goal numbers during any of the years (500 for the Entiat, 2,300 for the Methow, 2,300 for the Okanogan, and 3,000 for Wenatchee). In spite of recent increases, natural origin A&P remain well below viability thresholds for three out of the four populations, and the Okanogan River natural-origin spawner abundance estimates specifically are well below the recovery goal for that population. Three of four extant natural populations are considered to be at high risk of extinction and one at moderate risk (Table 5). The required improvements to improve the A&P estimates for the UCR steelhead

populations are at the high end of the range for all listed Interior Columbia DPS populations (NWFSC 2015).

Table 5. Summary of the key elements of A&P, diversity, and spatial structure and diversity (SS/D), and scores used to determine current overall viability risk for Upper Columbia River steelhead populations (NWFSC 2015). Risk ratings included very low (VL), low (L), moderate (M), high (H), and very high (VH)

Population (Watershed)	ICTRT Min Threshold	A&P	Natural Processes Risk	Diversity	Integrated SS/D	Overall Viability Risk
Wenatchee River	1,000	L	L	H	H	MT
Entiat River	500	H	M	H	H	H
Methow River	1,000	H	L	H	H	H
Okanogan River	750	H	H	H	H	H

Limiting Factors. Limiting factors for this species include (UCSRB 2007):

- Adverse effects related to the mainstem Columbia River hydropower system
- Impaired tributary fish passage
- Degradation of floodplain connectivity and function, channel structure and complexity, riparian areas, large woody debris recruitment, stream flow, and water quality
- Hatchery-related effects
- Predation and competition
- Harvest-related effects

Snake River Basin Steelhead DPS

This ESU was first listed as endangered under the ESA in 1991 (62 FR 43937). In October of 2017, NMFS released the final Snake River Spring/Summer-run Chinook Salmon and Steelhead Recovery Plan (NMFS 2017a). The most recent 5-year status review was completed in 2015 (2016b). The overall viability ratings for natural populations in the SRB steelhead DPS range from moderate to high risk. Four out of the five MPGs are not meeting the specific objectives in the Recovery Plan; the Grande Ronde MPG is tentatively rated as viable.

Spatial structure and diversity. The SRB steelhead DPS includes all naturally-spawned anadromous steelhead (*Oncorhynchus mykiss*) populations originating below natural and manmade impassable barriers in streams in the Snake River Basin of southeast Washington, northeast Oregon, and Idaho. Twenty-four historical populations (an additional three are extirpated) within six MPGs comprise the SRB steelhead DPS. Inside the geographic range of the DPS, 12 hatchery steelhead programs are currently operational. Five of these artificial programs are included in the DPS. With one exception, spatial structure ratings for all of the SRB steelhead populations were low or very low risk, given the evidence for distribution of natural production within populations. The exception was the Panther Creek population, which was given a high risk rating for spatial structure based on the lack of spawning in the upper sections. No new information was provided for the 2015 status update that would change those ratings (Table 6) (NWFSC 2015).

Table 6. Major population groups, populations, and scores for the key elements of A&P, diversity, and spatial structure and diversity (SS/D), used to determine current overall viability risk for Snake River Basin steelhead (NWFSC 2015). Risk ratings included very low (VL), low (L), moderate (M), high (H), and very high (VH). Maintained (MT) population status indicates that the population does not meet the criteria for a viable population but does support ecological functions and preserve options for recovery of the Distinct Population Segment.

Major Population Group	Spawning Populations (Watershed)	ICTRT min threshold	A&P	Diversity	Integrated SS/D	Overall Viability Risk*
Lower Snake River	Tucannon River	1,000	H?	M	M	H?
	Asotin Creek	500	M?	M	M	MT
Grande Ronde River	Lower Grande Ronde	1,000	**	M	M	MT?
	Joseph Creek	500	VL	L	L	Highly viable
	Upper Grande Ronde	1,500	V	M	M	Viable
	Wallowa River	1,000	H?	L	L	M?
Clearwater River	Lower Clearwater	1,500	M?	L	L	MT?
	South Fork Clearwater	1,000	H	M	M	H?/MT
	Lolo Creek	500	H	M	M	H?/MT
	Selway River	1,000	M?	L	L	MT?
	Lochsa River	1,000	M?H	L	L	MT?
Salmon River	Little Salmon River	500	M?	M	M	MT?
	South Fork Salmon	1,000	M?	L	L	MT?
	Secesh River	500	M?	L	L	MT?
	Chamberlain Creek	500	M?	L	L	MT?
	Lower MF Salmon	1,000	M?	L	L	MT?
	Upper MF Salmon	1,000	M?	L	L	MT?
	Panther Creek	500	M?	M	H	H?
	North Fork Salmon	500	M	M	M	MT?
	Lemhi River		**	M	M	MT
	Pahsimeroi River	1,000	M	M	M	MT?
	East Fork Salmon	1,000	M	M	M	MT?
	Upper Main Salmon	1,000	M	M	M	MT?
Imnaha	Imnaha River	1,000	M	M	M	M

* There is uncertainty in these ratings due to a lack of population-specific data.

** Insufficient data.

? Ratings are based on limited or provisional data series.

Abundance and productivity. Population-specific adult population abundance is generally not available for the SRB steelhead due to difficulties conducting surveys in much of their range. Evaluations in the 2015 status review were done using both a set of metrics corresponding to those used in prior Biological Review Team (BRT) reviews, as well as a set corresponding to the specific viability criteria based on ICTRT recommendations for this DPS. The BRT level metrics were consistently done across all ESUs and DPSs to facilitate comparisons across domains. The most recent 5-year geometric mean abundance estimates for the two long-term data series of direct population estimates (Joseph Creek and Upper Grande Ronde Mainstem populations) both increased compared to the prior review estimates; each of the populations increased an average of 2 percent per year over the past 15 years. Hatchery-origin spawner estimates for both populations continued to be low, and both populations are currently approaching the peak abundance estimates observed since the mid-1980s (NWFSC 2015).

Limiting factors. Limiting factors for this species include (NMFS 2017a):

- Adverse effects related to the mainstem Columbia River hydropower system
- Impaired tributary fish passage
- Degradation of floodplain connectivity and function, channel structure and complexity, riparian areas and large woody debris recruitment, stream flow, and water quality
- Increased water temperature
- Harvest-related effects, particularly for B-run steelhead
- Predation
- Genetic diversity effects from out-of-population hatchery releases
- Harvest-related effects
- Effects of predation, competition, and disease

Middle Columbia River Steelhead DPS

In 1999, NMFS listed MCR steelhead under the ESA and classified it as a threatened species (64 FR 14517). A recovery plan is available for this species (NMFS 2009), and this plan details much of the existing status information for the MCR steelhead. The most recent 5-year status review was completed in 2015 (NMFS 2016c). This species includes all naturally-spawned steelhead populations originating below natural and manmade impassable barriers from the Columbia River and its tributaries upstream of the Wind and Hood rivers (exclusive) to and including the Yakima River, excluding steelhead originating from the Snake River Basin. This DPS includes steelhead from seven artificial propagation programs (USDC 2014). The DPS does not currently include steelhead that are designated as part of an experimental population above the Pelton Round Butte Hydroelectric Project in the Deschutes River Basin, Oregon (USDC 2013). The ICTRT identified 17 extant populations in this DPS (ICTRT 2003; McClure et al. 2005). The populations fall into four MPGs: Cascade eastern slope tributaries (five extant and two extirpated populations), the John Day River (five extant populations), the Walla Walla and Umatilla rivers (three extant and one extirpated populations), and the Yakima River (four extant populations) (ICTRT 2003; McClure et al. 2005). Viability ratings for these populations range from extirpated to viable (Table 7) (NMFS 2009; NWFSC 2015).

Updated biological risk summary. The following is a summary from the status review update. More detailed information on the status and trend of these listed resources, and their biology and

ecology are in the status update (NWFSC 2015). The next status update will be completed in 2021.

There have been improvements in the viability ratings for some of the component populations, but the MCR Steelhead DPS is not currently meeting the viability criteria described in the Middle Columbia Steelhead Recovery Plan (NMFS 2009). In addition, several of the factors cited by the ICTRT (2005) remain as concerns or key uncertainties. Natural origin returns to the majority of populations in two of the four MPGs in this DPS increased modestly relative to the levels reported in the previous 5-year review. Abundance estimates for two of three populations with sufficient data in the remaining two MPGs (Eastside Cascades and Umatilla/Walla Walla) were marginally lower. Natural-origin spawning estimates are highly variable relative to minimum abundance thresholds across the populations in the DPS. Three of the four MPGs in this DPS include at least one population rated at low risk for A&P (NWFSC 2015). The survival gaps for the remaining populations are generally smaller than those for the other Interior Columbia Basin listed DPSs (NWFSC 2015). Updated information indicates that stray levels into the John Day River populations have deceased in recent years. Out of basin hatchery stray proportions, although reduced, remain high in spawning reaches within the Deschutes River Basin populations. In general, the majority of population level viability ratings remained unchanged from prior reviews for each MPG within the DPS.

Table 7. Major population groups, populations, and scores for the key elements of A&P, diversity, and spatial structure and diversity (SS/D), used to determine current overall viability risk for Middle Columbia River steelhead (NWFSC 2015). Risk ratings included very low (VL), low (L), moderate (M), high (H), very high (VH), and extirpated (E). Maintained (MT) population status indicates that the population does not meet the criteria for a viable population but does support ecological functions and preserve options for recovery of the Distinct Population Segment.

Major Population Group	Population (Watershed)	A&P	Natural Processes Risk	Diversity	Integrated SS/D	Overall Viability Risk
Cascade Eastern Slope Tributaries	Fifteenmile Creek	M	VL	L	L	MT
	Klickitat River	M	L	M	M	MT
	Deschutes Eastside	L	L	M	M	Viable
	Deschutes Westside	H	L	M	M	H
	Rock Creek	*	M	M	M	H
	White Salmon	N/A	N/A	N/A	N/A	E
	Crooked River	N/A	N/A	N/A	N/A	E
John Day River	Upper John Day	M	VL	M	M	MT
	North Fork John Day	VL	VL	L	L	Highly Viable
	Middle Fork John Day	L	L	M	M	Viable
	South Fork John Day	L	VL	M	M	Viable
	Lower John Day Tributaries	M	VL	M	M	MT
Walla Walla and Umatilla rivers	Umatilla River	M	M	M	M	MT
	Touchet River	H	L	M	M	H
	Walla Walla River	M	M	M	M	MT
Yakima River	Satus Creek	L	L	M	M	Viable
	Toppenish Creek	L	L	M	M	Viable
	Naches River	M	L	M	M	M
	Upper Yakima	M	M	H	H	H

* Re-introduction efforts underway (NMFS 2009)

Limiting factors. Limiting factors for this species include (NMFS 2009; NMFS 2011):

- Degradation of floodplain connectivity and function, channel structure and complexity, riparian areas, fish passage, stream substrate, stream flow, and water quality
- Mainstem Columbia River hydropower-related impacts
- Degraded estuarine and nearshore marine habitat
- Hatchery-related effects
- Harvest-related effects
- Effects of predation, competition, and disease

2.2.2 Status of Critical Habitat

In this section we examine the status of designated critical habitat affected by the proposed action by examining the condition and trends of the essential PBFs of that habitat throughout the designated areas (Tables 8 and 9). These features are essential to the conservation of the ESA-listed species because they support one or more of the species' life stages (e.g., sites with conditions that support spawning, rearing, migration and foraging). Rangewide, all habitat types are impaired to some degree, even though many of the watersheds comprising the fully

designated area are ranked as providing high conservation value. The proposed action, however, affects only freshwater rearing and freshwater migration habitats.

Table 8. Physical and biological features of critical habitat designated for ESA-listed species considered in this opinion (except Snake River spring/summer-run Chinook salmon, Snake River fall-run Chinook salmon, and Snake River sockeye salmon), and corresponding species life history events.

Physical or Biological Features		Species Life History Event
Site Type	**Site Attribute**	
Freshwater Rearing	Floodplain connectivity Forage Natural Cover Water quality Water quantity	Fry/parr/smolt growth and development
Freshwater Migration	Free of artificial obstruction Natural cover Water quality Water quantity	Adult upstream migration and holding Kelt (steelhead) seaward migration Fry/parr/smolt growth, development, and seaward migration

Table 9. Physical and biological features of critical habitats designated for Snake River spring/summer-run Chinook salmon, Snake River fall-run Chinook salmon, and Snake River sockeye salmon and corresponding species life history events.

Physical or Biological Features		Species Life History Event
Site Type	**Site Attribute**	
Spawning and juvenile rearing areas	Access (sockeye) Cover/shelter Food (juvenile rearing) Riparian vegetation Space (Chinook) Spawning gravel Water quality Water temp (sockeye) Water quantity	Adult spawning Embryo incubation Alevin growth and development Fry emergence from gravel Fry/parr/smolt growth and development
Adult and juvenile migration corridors	Cover/shelter Food (juvenile) Riparian vegetation Safe passage Space Substrate Water quality Water quantity Water temperature Water velocity	Adult sexual maturation Adult upstream migration and holding Kelt (steelhead) seaward migration Fry/parr/smolt growth, development, and seaward migration

For salmon and steelhead, NMFS' critical habitat analytical review teams (CHARTs) ranked watersheds within designated critical habitat at the scale of the fifth-field hydrologic unit code (HUC5) in terms of the conservation value they provide to each ESA-listed species that they support (NMFS 2005). The conservation rankings are high, medium, or low. To determine the

conservation value of each watershed to species viability, the CHARTs evaluated the quantity and quality of habitat features (e.g., spawning gravels, wood and water condition, side channels), the relationship of the area compared to other areas within the species' range, and the significance of the population occupying that area to the species' viability criteria. Thus, even if a location had poor habitat quality, it could be ranked with a high conservation value, if it were essential due to factors such as limited availability (e.g., one of a very few spawning areas), a unique contribution of the population it served (e.g., a population at the extreme end of geographic distribution), or the fact that it serves another important role (e.g., obligate area for migration to upstream spawning areas).

Interior Columbia Recovery Domain

Critical habitat has been designated in the Interior Columbia recovery domain (ICRD), which includes the Snake River basin, for SR spring/summer-run Chinook salmon, SR fall-run Chinook salmon, UCR spring-run Chinook salmon, SR sockeye salmon, MCR steelhead, UCR steelhead, and SRB steelhead. Major tributaries in the Oregon portion of the ICRD recovery domain include the Deschutes, John Day, Umatilla, Walla Walla, Grande Ronde, and Imnaha rivers.

Habitat quality in tributary streams in the ICRD varies from excellent in wilderness and roadless areas to poor in areas subject to heavy agricultural and urban development (Wissmar et al. 1994; NMFS 2009). Critical habitat throughout much of the ICRD has been degraded by intense agriculture, alteration of stream morphology (i.e., channel modifications and diking), riparian vegetation disturbance, wetland draining and conversion, livestock grazing, dredging, road construction and maintenance, logging, mining, and urbanization. Reduced summer stream flows, impaired water quality, and reduced habitat complexity are common problems for critical habitat in developed areas.

Migratory habitat quality in this area has been affected by the development and operation of the Columbia River System (CRS) dams and reservoirs in the mainstem Columbia River, Bureau of Reclamation tributary projects, and privately-owned dams in the Snake and Upper Columbia River basins. For example, construction of Hells Canyon Dam eliminated access to several likely production areas in Oregon and Idaho, including the Burnt, Powder, Weiser, Payette, Malheur, Owyhee, and Boise river basins (Good et al. 2005), and Grand Coulee and Chief Joseph dams completely block anadromous fish passage on the upper mainstem Columbia River.

Hydroelectric development modified natural flow regimes, resulting in higher water temperatures, changes in fish community structure leading to increased rates of piscivorous and avian predation on juvenile salmon and steelhead, and delayed migration for both adult and juveniles. Physical features of dams such as turbines also kill migrating fish. In-river survival is inversely related to the number of hydropower projects encountered by emigrating juveniles. Similarly, development and operation of extensive irrigation systems and dams for water withdrawal and storage in tributaries have altered hydrological cycles.

A series of large regulating dams on the middle and upper Deschutes River affect flow and block access to upstream habitat, and have extirpated one or more populations from the Cascades Eastern Slope major population. Also, operation and maintenance of large water reclamation

systems such as the Umatilla Basin and Yakima Projects have significantly modified flow regimes and degraded water quality and physical habitat in this domain.

Many stream reaches designated as critical habitat in the ICRD are over-allocated, with more allocated water rights than existing streamflow. Withdrawal of water, particularly during low-flow periods that commonly overlap with agricultural withdrawals, often increases summer stream temperatures, blocks fish migration, strands fish, and alters sediment transport (Spence et al. 1996). Reduced tributary streamflow has been identified as a major limiting factor for all listed salmon and steelhead species in this recovery domain except SR fall-run Chinook salmon and SR sockeye salmon (NMFS 2007; NMFS 2011).

Many stream reaches designated as critical habitat are listed on the state of Oregon's Clean Water Act section 303(d) list for water temperature. Many areas that were historically suitable rearing and spawning habitat are now unsuitable due to high summer stream temperatures. Removal of riparian vegetation, alteration of natural stream morphology, and withdrawal of water all contribute to elevated stream temperatures. Contaminants such as insecticides and herbicides from agricultural runoff and heavy metals from mine waste are common in some areas of critical habitat.

The ICRD is a very large and diverse area. The CHART determined that few watersheds with PBFs for Chinook salmon or steelhead are in good to excellent condition with no potential for improvement. Overall, most ICRD watersheds are in fair-to-poor or fair-to-good condition. However, most of these watersheds have some or high potential for improvement.

Despite these degraded habitat conditions, the HUCs that have been identified as critical habitat for these species are largely ranked as having high conservation value. Conservation value reflects several factors, including: (1) how important the area is for various life history stages; (2) how necessary the area is to access other vital areas of habitat; and (3) the relative importance of the populations the area supports relative to the overall viability of the ESU or DPS. The Columbia River corridor is ranked as high conservation value. The CHARTs noted that this corridor connects every watershed and population for all listed ESUs/DPSs with the ocean, and is used by rearing and migrating juveniles, and migrating adults, of every component population.

A summary of the status of critical habitats considered in this opinion is provided in Table 10.

Table 10. Critical habitat, designation date, Federal Register citation, and status summary for critical habitat considered in this opinion.

Species	Designation Date and Federal Register Citation	Critical Habitat Status Summary
Upper Columbia River spring-run Chinook salmon	9/02/05 70 FR 52630	Critical habitat encompasses four subbasins in Washington containing 15 occupied watersheds, as well as the Columbia River rearing/migration corridor. Most HUC5 watersheds with PBFs for salmon are in fair-to-poor or fair-to-good condition. However, most of these watersheds have some, or high, potential for improvement. We rated conservation value of HUC5 watersheds as high for 10 watersheds, and medium for five watersheds. Migratory habitat quality in this area has been severely affected by the development and operation of the dams and reservoirs of the Columbia River Systems.
Snake River spring/summer-run Chinook salmon	10/25/99 64 FR 57399	Critical habitat consists of river reaches of the Columbia, Snake, and Salmon rivers, and all tributaries of the Snake and Salmon rivers (except the Clearwater River) presently or historically accessible to this ESU (except reaches above impassable natural falls and Hells Canyon Dam). Habitat quality in tributary streams varies from excellent in wilderness and roadless areas, to poor in areas subject to heavy agricultural and urban development (Wissmar et al. 1994). Reduced summer stream flows, impaired water quality, and reduced habitat complexity are common problems. Migratory habitat quality in this area has been severely affected by the development and operation of the dams and reservoirs of the Columbia River Systems.
Snake River fall-run Chinook salmon	10/25/99 64 FR 57399	Critical habitat consists of river reaches of the Columbia, Snake, and Salmon rivers, and all tributaries of the Snake and Salmon rivers presently or historically accessible to this ESU (except reaches above impassable natural falls, and Dworshak and Hells Canyon dams). Habitat quality in tributary streams varies from excellent in wilderness and roadless areas, to poor in areas subject to heavy agricultural and urban development (Wissmar et al. 1994). Reduced summer stream flows, impaired water quality, and reduced habitat complexity are common problems. Migratory habitat quality in this area has been severely affected by the development and operation of the dams and reservoirs of the Columbia River Systems.
Snake River sockeye salmon	10/25/99 64 FR 57399	Critical habitat consists of river reaches of the Columbia, Snake, and Salmon rivers; Alturas Lake Creek; Valley Creek; and Stanley, Redfish, Yellow Belly, Pettit and Alturas lakes (including their inlet and outlet creeks). Water quality in all five lakes generally is adequate for juvenile sockeye salmon, although zooplankton numbers vary considerably. Some reaches of the Salmon River and tributaries exhibit temporary elevated water temperatures and sediment loads that could

Species	Designation Date and Federal Register Citation	Critical Habitat Status Summary
		restrict sockeye salmon production and survival. Migratory habitat quality in this area has been severely affected by the development and operation of the dams and reservoirs of the Columbia River Systems.
Upper Columbia River steelhead	9/02/05 70 FR 52630	Critical habitat encompasses 10 subbasins in Washington containing 31 occupied watersheds, as well as the Columbia River rearing/migration corridor. Most HUC5 watersheds with PCEs for salmon are in fair-to-poor or fair-to-good condition (NMFS 2005). However, most of these watersheds have some or a high potential for improvement. We rated conservation value of HUC5 watersheds as high for 20 watersheds, medium for eight watersheds, and low for three watersheds.
Snake River Basin steelhead	9/02/05 70 FR 52630	Critical habitat encompasses 25 subbasins in Oregon, Washington, and Idaho. Habitat quality in tributary streams varies from excellent in wilderness and roadless areas, to poor in areas subject to heavy agricultural and urban development (Wissmar et al. 1994). Reduced summer stream flows, impaired water quality, and reduced habitat complexity are common problems. Migratory habitat quality in this area has been severely affected by the development and operation of the dams and reservoirs of the Columbia River Systems.
Middle Columbia River steelhead	9/02/05 70 FR 52630	Critical habitat encompasses 15 subbasins in Oregon and Washington containing 111 occupied watersheds, as well as the Columbia River rearing/migration corridor. Most HUC5 watersheds with PBFs for salmon are in fair-to-poor or fair-to-good condition (NMFS 2005). However, most of these watersheds have some or a high potential for improvement. We rated conservation value of occupied HUC5 watersheds as high for 80 watersheds, medium for 24 watersheds, and low for 9 watersheds.

HUC5=Fifth-field Hydrologic Code; ESU=Evolutionarily Significant unit; PBF= Physical or Biological Feature; PCE=Primary Constituent Element.

2.3. Action Area

"Action area" means all areas to be affected directly or indirectly by the federal action and not merely the immediate area involved in the action (50 CFR 402.02). The action area is near Columbia River Mile (RM) 285 in the John Day Reservoir, approximately 7 miles downstream from McNary Dam. The action area includes the in-water project site (sheet pile, cement, micropiles, pipes, and screen installation), the pump station and supporting facilities, the barge, equipment use and storage locations, stockpile locations, shoreline, riparian, and upland areas surrounding the AgriNorthwest pump station and areas upstream and downstream of the in-water work area that are likely to be affected by the proposed action, both directly and indirectly. The action area totals approximately 8 acres.

The in-water effects of the action beyond the project footprint are based on the potential for upstream and downstream turbidity and sedimentation associated with the installation of the sheet pile wall, micropiles, pipes and screens. There is potential for suspended sediments to extend up to 200 feet around and 500 feet downstream of the in-water work area; however, it is anticipated water quality effects from turbidity will dilute and disperse to background levels quickly in the Columbia River. Sound effects from the vibratory hammer are anticipated to occur up to 72 feet from the installed sheet pile. This is within the potential extent of effects due to sedimentation and turbidity.

The action area is primarily used as a migration corridor for all seven species of salmon and steelhead considered in this opinion. Juvenile salmonids may remain in slow water areas of the mainstem Columbia River for an extended period for rearing as they move downstream, and upstream migrating adults will rest and hold for short periods, generally in deep pools. The entire action area is designated EFH for Chinook and coho salmon.

2.4. Environmental Baseline

The "environmental baseline" refers to the condition of the listed species or its designated critical habitat in the action area, without the consequences to the listed species or designated critical habitat caused by the proposed action. The environmental baseline includes the past and present impacts of all federal, state, or private actions and other human activities in the action area, the anticipated impacts of all proposed federal projects in the action area that have already undergone formal or early section 7 consultations, and the impact of state or private actions which are contemporaneous with the consultation in process. The consequences to listed species or designated critical habitat from ongoing agency activities or existing agency facilities that are not within the agency's discretion to modify are part of the environmental baseline (50 CFR 402.02).

The action area includes the mainstem Columbia River. Current conditions within much of the mainstem Columbia River are degraded relative to historic conditions; a reflection of a multitude of actions whose effects frame the environmental baseline in the action area. The mainstem dams and reservoirs, such as John Day Reservoir which includes the action area in this consultation, continue to substantially alter the mainstem migration corridor habitat. The reservoirs have increased the cross-sectional area of the river, reducing water velocity, altering the food web, and creating habitat for native and non-native species that are predators, competitors, or food sources for migrating juvenile salmon and steelhead. Travel times of migrating smolts increase as they pass through the reservoirs (compared to a free-flowing river), increasing exposure to both native and nonnative predators, and some juveniles are injured or killed as they pass through the dams (turbines, bypass systems, spillbays, or surface passage routes) (NMFS 2019). However, overall passage conditions and resulting juvenile survival rates in the migration corridor have improved substantially since the 1990's, when these species were listed. This is most likely the result of improved structures and operations and predator-management programs at the Corps' mainstem projects (24-hour volitional spill, surface passage routes, improved juvenile bypass systems, predator-management measures, etc.).

In addition, numerous anthropogenic features or activities near the action area (e.g., dams, pump stations, marinas, docks, roads, railroads, bank stabilization, and landscaping) have become

permanent fixtures on the landscape, and have displaced and altered native riparian habitat. Consequently, the potential for normal riparian processes (e.g., litterfall, channel complexity, and large wood recruitment) to occur is diminished and aquatic habitat has become simplified. Shoreline development has reduced the quality of nearshore salmon and steelhead habitat by eliminating native riparian vegetation, displacing shallow water habitat with fill materials, and by further disconnecting the Columbia River from historic floodplain areas. Furthermore, riparian species that evolved under the environmental gradients of riverine ecosystems are not well suited to the present hydraulic setting of the action area (i.e., static, slackwater pools), and are thus often replaced by invasive, non-native species. The riparian system is fragmented, poorly connected, and provides inadequate protection of habitats and refugia for sensitive aquatic species.

The Columbia River shoreline, shallow water habitat, and natural vegetation is altered with in-water structures, rock, and riprap. Shoreline developments and alterations have reduced rearing habitat suitability (e.g., less habitat complexity, reduced forage base), reduced spring water velocities (which hampers downstream migration by smolts), and created better habitat for juvenile salmonid predators (e.g., birds, and native and non-native fish). These factors further limit habitat function by reducing cover, attracting predators and reducing foraging efficiency for juvenile salmonids. We are unaware of any fish surveys in the action area specifically, but the Columbia River in the action area likely serves as rearing habitat and as a migration corridor for spring- and fall-run Chinook salmon and steelhead and potentially sockeye salmon. Project activities will occur during the winter recommended in-water work period, when adults do not typically occupy the area. An occasional adult steelhead could be present year round in the mainstem Columbia River. However, it is highly unlikely adult steelhead will migrate along the shoreline habitat where the proposed in-water work will occur.

John Day Dam has created reservoir conditions in the action area, with daily fluctuations in water level. John Day Reservoir is considered water quality limited by the Oregon Department of Environmental Quality (ODEQ) and it is on the Clean Water Act section 303(d) list for water temperature and pH (ODEQ 2006). Water temperatures in the action area are often elevated in the summer and early fall. Chemical contamination, nutrients and dissolved oxygen are also issues of water quality concern in the area. Turbidity in the reservoir is often elevated.

The action area is in a rural area dominated by irrigated agricultural use. The land area of the project consists of maintained graveled parking areas surrounding the pump station and supporting facilities. The pump station consists of a sheet pile barrier which begins at the shoreline and extends approximately 100 feet into the river channel. The sheet pile barrier on the face of the pump station is about 140 feet wide. Some sections of sheet pile were partially cut/removed previously to improve flow across the interior barrel screens, including windows cut out on the upstream and streamward side of the structure, and a large section removed on the downstream side of the structure. The current water intake screens have been in place since the mid-1990s. Each pump at the site is individually screened by a barrel screen inside the pump station structure. The current intake screens have historically had issues with the accumulation of debris on the screens resulting from uneven water velocities through the screens.

Within the action area the river bottom is comprised of roughly 10-inch diameter and smaller cobbles and rock. Aquatic vegetation is sparse, and there is no large woody debris, over-hanging vegetation, undercut banks, pools, riffles, or other more complex forms of aquatic cover.

The shoreline at the pump station is armored with rock. Within and adjacent to the project area, the sparse riparian vegetation is dominated by shrubs and annual non-native invasive species. There are no trees within the project area and currently minimal local potential for large or small wood contribution into the river.

The adjacent properties are owned by the Corps to the east and west, and the Burlington Northern and Santa Fe Railroad railway tracks run parallel to the shoreline in the project area to the north.

Water will continue to be withdrawn using the existing facilities whether or not the new screens are installed. The existing water withdrawals are part of the current environmental baseline for the site. The proposed action does not include an increase in water withdrawals from the Columbia River.

2.5. Effects of the Action

Under the ESA, "effects of the action" are all consequences to listed species or critical habitat that are caused by the proposed action, including the consequences of other activities that are caused by the proposed action. A consequence is caused by the proposed action if it would not occur but for the proposed action and it is reasonably certain to occur. Effects of the action may occur later in time and may include consequences occurring outside the immediate area involved in the action (see 50 CFR 402.17). In our analysis, which describes the effects of the proposed action, we considered 50 CFR 402.17(a) and (b).

2.5.1 Effects on Species

The action area is used by different-sized groups and age classes of steelhead and salmon as rearing, holding, and migration habitat. In general, juvenile salmon of different sizes often have different behavior, disposition to migrate, and distribution in reservoirs (Peven 1987), which will influence the degree to which effects of the project are experienced by individual fish. Some juvenile steelhead and Chinook salmon overwinter in the John Day Reservoir. A few adult steelhead could be present year-round in the mainstem Columbia River.

The majority of adult Chinook salmon migrate through the action area between April and October. Those passing John Day Dam from April 1 to June 5 are considered spring-run. Those passing June 6 to August 5 are considered summer-run, and those passing after August 6 are considered fall-run (Columbia Basin Research 2013). Adult sockeye migrate through the action area June through September. Adult steelhead migrate through the action area throughout the year in small numbers, but the majority of adults move through between June and October. In a study by Johnson et al. (2008), the vast majority of adult steelhead and Chinook salmon migrated at a depth between 6 and 15 feet in mainstem reservoirs, and frequently altered their depth in the water column. In another study, Hughes (2004) noted that smaller fish swim closer to the streambank than larger fish, and very few adult fish swim in the thalweg of the channel during

upstream migration. Since project activities will occur from January 1 to February 28, when adult salmon are not typically present, NMFS does not expect adult salmon to be affected by the proposed action. Adult steelhead, mostly MCR steelhead, and mostly kelts, will be present in the action area in low numbers during the latter portion of the work window.

Millions of juvenile salmonids migrate through John Day Reservoir each year. Ocean-type salmon migrate downstream through the action area as subyearling juvenile fish, generally leaving natal areas within days to weeks following their emergence from the gravel. Subyearling Chinook salmon express two peak movements downriver; between April and June, and then from mid-June through August. Although there is considerable variability in the freshwater migration timing of salmon and steelhead, the progeny of upper river tributaries, such as Snake River fall-run Chinook salmon, typically enter the Columbia River later, rearing for weeks to months after arrival. Some remain in freshwater for extended periods until reaching a larger size (more than 75 millimeters) (Levy and Northcote 1982; Levings et al. 1986; MacDonald et al. 1988). While peak movement of juvenile salmonid outmigration does not overlap with project construction, all individuals will be exposed to the long-term effects of the existence of the new in-water structures from this proposed action and the associated indirect effects.

Subyearling Chinook salmon generally remain close to the water surface, favoring water column habitat less than 6 feet deep and where currents do not exceed 0.1 feet per second. They seek lower energy areas where waves and currents do not require them to expend considerable energy to remain in position while they consume invertebrates that live on or near the substrate. These areas typically have fine-grain substrates supporting benthic prey production. Subyearling Chinook salmon rear in the littoral zone from approximately March through June (Chapman 2007). As they grow, they increasingly use deeper water, though they continue to move into the shallows at night to rest on the bottom. As the subyearlings begin to move downstream, they continue to use the littoral zone for feeding and resting. Some subyearlings remain in the mainstem Columbia River to overwinter and migrate downstream as yearlings. These may be either ocean or stream type fish.

Spring-run Chinook salmon and sockeye salmon mainly use deeper water during their downstream migration, though some fish are found in the littoral zone (Mains and Smith 1964; Dauble et al. 1989). Dauble et al. (1989) caught 52 percent of subyearling Chinook salmon, 7 percent of yearling Chinook salmon, and 3 percent of sockeye salmon within 100 feet of shore in water 5.9 meters (19 feet) deep, or less. Additionally, the most abundant group in the littoral zone, subyearling Chinook salmon, is likely composed of both fall and spring (ocean and stream) type Chinook salmon. In most cases, these groups are visually indistinguishable.

Older juvenile salmon and steelhead (+1 age class) use a variety of habitats including nearshore, off-channel, mid-channel, and deep-water habitats. Dauble et al. (1989) observed that yearling Chinook salmon smolts were often abundant just after sunset in shallow nearshore areas (less than 30 cm deep) of low current velocity. While Beeman and Maule (2006) observed a difference in daytime swim depth between yearling steelhead and yearling Chinook salmon, with steelhead migrating at a mean depth of 6 feet and Chinook salmon migrating at a mean depth of 10 feet. A study by Timko et al. (2011) recorded juvenile steelhead migrating in the top 5 to 15

feet of the water column in the Priest Rapids Project (which is located upstream of the project area).

In addition, investigations in the Snake River Basin indicate that about half of the subyearling Chinook salmon observed in the Snake River are actually spring-run Chinook salmon (Marshall et al. 2000). Connor et al. (2001) found that some spring-run Chinook salmon migrated up to 500 miles downstream of their natal rearing areas, vastly expanding the amount of habitat available to these fish. They also found that many of these subyearling-type spring-run Chinook salmon dispersed into shoreline areas of the mainstem, presumably for foraging and rearing, a behavior far more typical of fall-run Chinook salmon. Bradford and Taylor (1997) reported similar results with subyearlings dispersing downstream from natal tributaries to mainstem habitats. This mostly occurred during the night with fish moving to the stream margins and nearshore areas during the day. Therefore, it is reasonable to expect subyearling spring-run Chinook salmon to occasionally use nearshore, mainstem habitats just as fall subyearlings do.

Based on the above-described life history behaviors of the listed species, the proposed action has the potential to affect UCR spring-run Chinook salmon, UCR steelhead MCR steelhead, SR spring/summer-run and fall-run Chinook salmon, SR sockeye salmon, and SRB steelhead. In-water work will occur January 1 through February 28. Upstream migration of UCR and SR adult spring-run Chinook salmon, SR fall-run Chinook salmon, and SR sockeye salmon occurs March through November, and adults of these ESUs will not be present or affected by the project. UCR, MCR, and SRB adult steelhead could potentially overwinter in the action area. Therefore, they could be exposed to project effects. The majority of out-migrating spring-and fall run Chinook salmon, sockeye salmon, and steelhead juveniles will have passed through the action area prior to the in-water work window, but some juvenile Chinook salmon and steelhead may overwinter in the action area, so they could also be exposed to project effects. NMFS anticipates the proposed action will affect all species and life stages by new permanent in-water structures and increases in piscivorous predators. The Project will affect juveniles from all seven NMFS-listed species in the action area by causing physical and biological changes to the environmental baseline, including effects during in-water construction.

The proposed action is reasonably likely to have the following effects on the ESA-listed salmon and steelhead covered in this opinion: (1) temporary exposure to elevated total suspended solids (TSS) and turbidity; (2) increased risk of exposure to toxic contamination; (3) temporary exposure to increased sound levels from pile driving; (4) small losses of benthic habitat and prey base; (5) increased risk of predation from piscivorous fish; and (6) disturbance and displacement from sheet pile, micropile, steel pipe, and screen installation; and barge movements. All work will be conducted during the in-water work window, January 1 to February 28.

Entrapment

Overwintering adult steelhead and juvenile Chinook salmon and steelhead could be entrapped during pile wall installation. The pump station is currently open to the river and fish can freely swim inside the structure. The newly installed sheet pile wall will close off the interior of the structure from the river, which could potentially result in fish entrapment. Prior to the structure

being sealed off from the river, divers will inspect the interior of the structure to ensure that no salmonids are present. If fish are detected, they will be driven out of the openings in the structure using moving curtains; this will not include direct capture or handling of fish. Due to the low likelihood of salmonids utilizing the interior of the structure, the winter in-water work window, and all fish in the structure being herded out, the likelihood of entrapment in the structure is extremely low and is not expected to result in harm or harassment to any of the federal ESA-listed species.

Mechanical Injury

Direct injury or mortality could occur from pile driving if salmon or steelhead adults and juveniles are in the immediate vicinity of the piles being driven. If adult or juvenile steelhead and salmon are in the vicinity, they will likely flee once construction activities begin. The risk of physical injury or death from the proposed pile driving is extremely small since the area of construction activities is small in comparison to alternative migration paths, all salmon and steelhead will likely flee to suitable habitat nearby once pile driving begins, and all pile driving machinery will be on a barge or the shoreline.

Water Quality

The proposed project includes in-water work below the ordinary high water mark (OHWM) due to installation of the sheet pile wall and 11 water intake screens structures (11 screens, 11 steel pipes, and 44 micropiles). Heavy machinery working in-water and pile driven into the streambed can lead to construction-related effects to listed fish from changes in water quality.

Turbidity. The proposed action will affect water quality during installation of 200 feet of new sheet pile wall, 11 intake screens, 11 60-inch-diameter steel pipes, and 44 8-inch-diameter micropiles by temporarily increasing delivery of sediment to the waterway and increasing turbidity in the water column. Increased fine sediment can be detrimental to juvenile salmon and steelhead in several ways including avoidance of the area, abandonment of cover, stress, and reduced growth rates (Newcombe and Jensen 1996). Turbidity from increased fine sediment may disrupt salmon and steelhead feeding and territorial behavior and may displace fish from preferred feeding and resting areas.

Sheet pile driving will mobilize sediments and likely elevate TSS and turbidity levels in the immediate work area and a short distance (500 feet) downstream. For approximately 4 days (32 hours), pulses of suspended sediment will be created while sheet piles are driven to construct the pump station enclosure. Sheet piles will be placed and driven one sheet after another, with only a small time increment between each successive sheet. Installation will not occur at night. The pulses of suspended sediment will diminish quickly after the daytime construction activities are stopped. We expect the current will quickly disperse suspended sediments such that concentrations will remain low and the duration of potential exposure to salmonids will be a short-term effect.

NMFS does not anticipate dredging, installation of a concrete floor, or removal of existing screens within the sheet pile to have effects to listed salmonids. The newly installed sheet pile

wall will effectively contain any turbidity caused inside the structure during sediment removal and concrete placement.

Increased turbidity in the water column is also expected due to placement of the intake screens, pipes, and micropiles. Installation of the new intake screen assemblies will occur outside the new sheet pile wall system without using sediment containment measures. The 11 screens and pipes will be installed using a crane mounted on a barge. The intake pipes will rest on the river bottom or be supported slightly above it, and the tee screens will be mounted to the top of the pipe. Drilling of the micropiles will occur inside a steel pipe casing that extends from the bottom of the drilled hole to an elevation above the waterline. The pipe casing provides containment of the drilling mud, drilled material, and grout. After the grout has hardened, the casing and material above the required micropile height will be removed from the river. Installation of screens, steel pipes, and micropiles will mobilize sediments and likely elevate TSS and turbidity levels in the immediate work area and a short distance (500 feet) downstream.

The effects of suspended sediment and turbidity on fish range from beneficial to detrimental. Elevated TSS have been reported to enhance cover conditions, reduce piscivorous fish/bird predation rates, and improve survival, but elevated TSS have also been reported to cause physiological stress, reduce feeding and growth, and adversely affect survival. Although fish that remain in turbid waters experience a reduction in predation from piscivorous fish and birds (Gregory and Levings 1998), chronic exposure can cause physiological stress responses that can increase maintenance energy and reduce feeding and growth (Lloyd et. al 1987; Redding et. al. 1987; Servizi and Martens 1991).

NMFS expects that the turbidity levels generated by this action will be sufficient in the action area to cause temporary behavioral changes to salmon and steelhead that include changes in feeding and movement of fish within turbidity plumes (Berg And Northcote 1985). Sheet wall and screen assembly construction and increased TSS will occur up to several hours each day. Based on similar projects, suspended sediments will likely be elevated for a few days following project completion, and are not expected to exceed 10 percent above background levels at 200 feet above and 500 feet downstream from the construction area. NMFS does not expect any fish to be injured or killed by exposure to turbidity caused by this action. The increase in turbidity will be minor and only occur in a small area of the river. It is expected that turbidity at the construction site will quickly dissipate downstream, since on average the Columbia River passes through the action area at flows averaging 168,000 cubic feet per second (cfs) in January and 174,000 cfs in February. Given the small work area, the short duration of in-water work and increased turbidity, and the small number of fish expected to be in the area, the effects of increased turbidity on ESA-listed salmonids are expected to be small, isolated, and short-term.

Contaminants. Additional impairment of water quality may result from accidental releases of fuel, oil, and other contaminants that can injure or kill aquatic organisms. The project will include the use of heavy equipment deployed on either the structure deck or a floating barge, including: drilling and grouting equipment, a cement truck, an excavator, and a crane. There is the potential for accidental spills of petroleum products or other hazardous materials into the river from this equipment. Petroleum-based contaminants, such as fuel, oil, and some hydraulic fluids, contain polycyclic aromatic hydrocarbons (PAHs), which can kill salmon at high

concentrations, and can cause sublethal, adverse effects at lower concentrations (Meador et al. 2006).

Spills that make their way into the Columbia River could harm fish. However, NMFS anticipates PAH releases of only very small quantities (ounces) are likely with each accidental release or spill. Conservation measures will be implemented to minimize the use of toxic substances and prevent or contain any spill that may occur. The contractor will develop and implement a site-specific SPCC plan for the project and will be responsible for containment and removal of any releases. The contractor will make the SPCC plan available for review by the Corps and NMFS. Equipment used in water and along the shoreline will be high-pressure cleaned prior to use on the project, checked for leaks, and will have oils and hydraulic fluids replaced with biodegradable fluids and oils. The contractor and applicant will allow monitoring of the site by the Corps and NMFS during construction activities. Fuel and liquids will not be stored at the site. Instead a fuel/maintenance truck will come to the site and fill up equipment in the gravel area, outside the security fence where it will be 50 to 60 feet from the shoreline.

The conservation measures and spill containment plan will minimize the risk of a spill and, if a spill does occur, will minimize its dispersal and exposure to fish. Any leak will likely be contained within the immediate area where it will only have short-term adverse effects on water quality and macroinvertebrates. The project will occur January1–February 28, when the fewest fish are likely to be present. There is also suitable habitat in the immediate vicinity of the action area for fish to move to, if needed. For these reasons, the effects on water quality from the proposed action will be minimal and harm or harassment of ESA-listed anadromous species from water quality conditions will also be minimal. NMFS does not expect any fish to be injured or killed by exposure to accidental releases of fuel, oil, and other contaminants caused by this action.

Sound Pressure Levels and Noise

Pile driving will create hydroacoustic disturbance to any listed fish present in the action area. Pile driving increases sound pressure levels and noise during construction. The project entails the placement of 200 feet of sheet pile. All sheet piles will be installed using only a vibratory hammer. The cumulative duration of peak underwater noise from pile-driving is anticipated to be up to 32 hours and work is expected to take 4 days. Pile driving operations will only be completed during the day.

Fishes with swim bladders (including salmonids) are sensitive to underwater impulsive sounds (i.e., sounds with a sharp sound pressure peak occurring in a short interval of time). As the pressure wave passes through a fish, the swim bladder is rapidly compressed due to the high pressure, and then rapidly expanded as the under pressure component of the wave passes through the fish. Fish respond differently to sounds produced by impact hammers than to sounds produced by vibratory hammers. Vibratory hammers produce a more rounded sound pressure wave with a slower rise time. Because the more rounded sound pressure wave produced by vibratory hammers produces a slower increase in pressure, the potential for injury and mortality is reduced.

A multi-agency work group determined that to protect listed species, sound pressure waves should be below the threshold of 206 decibels (dB) and, for cumulative strikes, either 187 dB sound exposure level (SEL) where fish are larger than 2 grams or 183 dB SEL where fish are smaller than 2 grams. In addition, a "harassment" threshold below sound pressure levels of 150 dB is applied for behavioral effects to individual listed fish (NMFS 2008a). Any salmon or steelhead within a certain distance of the source (i.e., the radius where the root mean square (RMS) sound pressure level will exceed 150 dB re: 1 µPa2) will be exposed to levels that cause changed behavior. For this project, estimated sound pressure levels for sheet pile can be as much as 175 dB, 160 RMS, and 160 SEL (California Department of Transportation 2009).

Some rearing juvenile salmon and steelhead may experience the effects of these sound pressure levels. Based on estimates using the NMFS hydroacoustic calculator, we anticipate that behavioral effects (150 dB RMS) will occur in a semicircle out to 150 feet from each sheet pile installed by a vibratory hammer. However, there are a multitude of possible behavioral responses that may occur; from no change, to a mild awareness, a startle response, small temporary movements, or larger movements that displace the fish from their normal location. The result of exposure could be a temporary threshold shift in hearing due to a temporary fatiguing of the auditory system that can reduce the survival, growth, and reproduction of the affected fish by increasing the risk of predation and reducing foraging or spawning success (Stadler and Woodbury 2009).

It is difficult for NMFS to determine the type of response an individual fish will make or what type of effect that response has to a population. However, pile driving is reasonably certain to alter salmon and steelhead rearing and migration behavior. In general, it is reasonable to assume some fish will exhibit a behavioral response over the duration of pile driving activity and will likely flee the immediate area. Peak sound pressure (175 decibels [dB] [re: 1µPa]) and SEL (160 dB) produced from vibratory driving sheet pile are below thresholds known to injure fish, and thus there is no reason to assume that any fish will be injured by sound pressure. NMFS anticipates the majority of fish will respond by adjusting their behavior.

The use of a vibratory hammer on the sheet pile wall, with no hard driving to refusal, will greatly reduce the level of noise associated with the work. Also, the noise and disturbance of driving pile is ephemeral, and timing restrictions will minimize the number of fish that will be exposed. NMFS expects some fish will be harassed by the action and flee the area. NMFS does not believe that this response will alter the fitness of juvenile salmon or adult or juvenile steelhead to a point where any fish will be killed.

Changes to Physical Features of Habitat

The Columbia River, both upstream and downstream of the project area, provides foraging, rearing, and migration habitat for all listed species covered in this opinion. The nearshore shallow water component provides overwintering habitat, as well as important spring and summer foraging habitat for salmon and steelhead during their outmigration.

The addition of in- and over-water structures and changes in benthic habitat can alter a variety of physical processes, which in turn affect fish behavior and fish condition. The proposed action

includes adding a temporary over-water structure (barge) and permanent in-water structures (screen assemblies) in the John Day Reservoir. These structures will change the ambient light regime, water velocity, and benthic habitat in the project area, and will likely affect fish behavior and attract smallmouth bass and pikeminnow. The use, and sometimes selection of, in- and over-water structures by smallmouth bass and northern pikeminnow has been documented (Pribyl et al. 2004; Celedonia et al. 2008).

Ambient light/shading. The reduction of ambient light (e.g., light attenuation and shading) is one of the primary mechanisms by which in-water (screens and pilings) and overwater structures (moored vessels) adversely affect salmon and steelhead. Light levels are a determining factor that can impair fitness and survival in juvenile salmonids by altering certain behaviors, such as migration, feeding success, and predator avoidance (Nightingale and Simenstad 2001; Rondorf et al. 2010). Overwater structures can substantially reduce light levels necessary for these behaviors.

The proposed action will temporarily increase the amount of over-water structure in the Columbia River by 2,800 square feet. A floating barge (approximately 40 feet by 70 feet) will be deployed for approximately 2 months during the in-water work window. This barge can provide cover and preferred habitat for ambush predators such as northern pikeminnow and smallmouth bass, which prey on juvenile salmonids in the Columbia River System (Vigg et al. 1991; Tabor et al. 2004; Zimmerman and Ward 1999; Fritts and Pearsons 2004). It can also create a shaded area that can increase a predator's capture efficiency of prey. In general, predation on juvenile salmonids increases as light intensity decreases (Petersen and Gadomski 1994; Tabor et al. 1998). Increased predation may change fish behavior including delayed migration, alteration of schooling behavior, and may result in injury or death of juvenile salmon and steelhead.

Water velocity. Eleven tee screens (1,650 square feet) will be installed approximately 20 feet below the OHWM, approximately 4 feet below the low water surface elevation, with 60-inch-diameter steel pipes and 8-inch-diameter micropiles (1,815 square feet) installed on, or just above, the river bottom. These structures may also attract smallmouth bass and northern pikeminnow. Pilings placed in flowing water create low-velocity microhabitats that allow predators such as smallmouth bass and northern pikeminnow to conserve energy by holding in these areas and catching prey as it passes (Peterson et al. 1993).

By constructing the screen structures 127 to 135 feet from shore and in deeper water (approximately 20 feet below the OHWM, 4 feet below low water surface elevation), the interaction between predators and juvenile salmon will likely be reduced because juvenile salmon are rearing in shallow areas near shore. But as juvenile salmon and steelhead grow and move to offshore areas, and during downstream migration when juveniles are located farther from shore, the overlap in habitat use between juvenile salmon, smallmouth bass, and northern pikeminnow increases the potential for predation. Therefore, the installation of permanent in-water structures will likely increase the number of predators which may change fish behavior including delayed migration, alteration of schooling behavior, and may result in injury or death of juvenile salmon and steelhead.

The extent of these effects on fish is difficult to quantify in terms of the number of affected fish without elaborate and expensive studies. We infer that changing the lighting regime and creating velocity barriers will increase predation of juvenile salmon and steelhead.

Benthic habitat. Sheet pile and cement floor installation will eliminate 4,260 square feet (0.10 acres) of near-shore, shallow water, and benthic habitat from within the pump station. Steel pipe and micropile installation will harden and degrade approximately 1,815 square feet (0.04 acres) of benthic habitat. Alteration of the riverbed and substrate can result in the removal of benthic organisms, resulting in an immediate, localized reduction of food in the affected area. The disturbed area within the sheet pile wall and covered by the steel pipes will not recover due to the presence of the permanent in-water structures, and result in a small, localized permanent reduction of food.

Aside from the initial physically disruptive effects, there is a concern for the speed of the recovery (repopulation) of bottom areas that are disturbed. Recolonization of disturbed sites can begin quickly, although reestablishment of a more stable benthic community may take several months or years after the work is completed (Barton and Dwyer 1997; Fowler 2004; Korsu 2004). NMFS expects the new screen assemblies to alter the availability of macroinvertebrates to salmonids and steelhead during construction and 2 to 3 months post-construction. Drifting invertebrates from upstream are expected to recolonize the affected areas once the proposed project is completed. Because the prey base will be reduced for a few months, spring migrating juveniles that temporarily occupy the action area will experience the effects of this loss. However, due to the small area that will be affected, the effects on fish will be minimal. Therefore, any effects to the growth, survival, and distribution of ESA-listed salmonids in the action area will be small, isolated, and temporary.

Intake Entrainment/ Impingement

The potential for injury or mortality to juvenile salmonids from impingement or entrainment at the fish screens associated with the Project water intake structures depends on multiple factors. These include the species and life stages of fish present during the irrigation season, the number of fish present in the intake vicinity, the location and depth of the intake and screen structures within the river, water velocities approaching and sweeping over the screens, the design and orientation of the screens, and maintenance features to keep the screen openings clear of debris.

The new intake screens are located approximately 130 feet from shore, 4 feet below minimum pool elevation, and 20 feet below the OHWM. The screens include an automated air burst cleaning system to prevent debris buildup, and meet the current NMFS slot opening standard of 0.069 inches with a maximum approach velocity of 0.4 feet per second. The screen designs have been reviewed by a NMFS fish passage engineer and meet current NMFS design criteria to protect the species and life stages of salmonids expected in the action area. Juvenile salmon and steelhead of different sizes have different behavior and different distribution in the John Day Reservoir. However, given the protective design features, NMFS does not anticipate injury or mortality to juvenile steelhead or salmon to occur from entrainment or impingement.

Instream Water Withdrawals

There are no new permits or increased water withdrawals associated with this project.

Relevance of Effects on Individual Fish to Salmonid Population Viability

NMFS assesses the importance of habitat effects in the action area (on individual fish) to their ESUs or DPSs by examining the relevance of those effects to the characteristics of VSPs. The characteristics of VSPs are abundance, population growth rate (productivity), spatial structure, and diversity. While these characteristics are described as unique components of population dynamics, each characteristic exerts significant influence on the others. For example, declining abundance can reduce spatial structure of a population, and when habitats are less varied, then diversity among the population declines.

Abundance. Small populations are at a greater risk of extinction than larger populations because of several processes that affect population dynamics. For this reason, it is important to look at what parts of this project will affect salmonid abundance. The action will result in a small, localized permanent reduction of food. It will also result in a short-term loss of benthic prey items, but at a time when few fish will be present. In-water construction may have short-term effects due to vibratory sounds, increases in turbidity, fine sediments, and chemical contamination modifying the behavior of individual salmonids in the action area. Abundance is not expected to change as a result of construction activities. The Project will add structures that predators may exploit to more effectively ambush juveniles of all of the subject species. The extent of this predation cannot be precisely estimated but it can be assumed to be small because the action area is small and not occupied by large numbers of the subject species. Therefore, we do not anticipate increased predation will affect the abundance of adult returns of any of the subject species to more than a very minimal degree.

Productivity. The proposed action will create and maintain conditions that favor predators of salmon and steelhead. Predation will continue to exert a sustained detrimental effect on listed species, each of which already experience low population growth rates. The extent of this predation cannot be precisely estimated but it can be assumed to be small because the amount of additional structure is small, particularly relative to the size of the John Day Reservoir; which limits the number of the subject species that might be exposed to increased predation. We do not anticipate that the action will reduce the productivity of any of the subject species to more than a minimal degree.

Spatial structure. NMFS does not expect the proposed project to affect the spatial structure of any of the affected species more than a minimal amount because the action area does not include spawning areas or tributary habitat. In addition, the project will not prevent adult salmon or steelhead from returning to their natal streams.

Diversity. The project is not likely to differentially affect one life history strategy over another to more than a minimal degree because of the very small proportion of each of the species' populations that will be affected by project-related activities, or using the action area for rearing

or migration. For this reason, projects effects on diversity will not be more than minimal, at most.

Summary. Because effects on the abundance, productivity, spatial structure, and diversity are not expected to be more than minimal, only minimal effects would occur at the population scale for any of the affected species.

2.5.2 Effects on Critical Habitat

Implementation of the proposed project is likely to affect freshwater rearing and freshwater migration sites of ESA-listed salmonids. The critical habitat PBFs most likely to be affected are substrate, water quality, forage, and safe passage.

Substrate

The proposed action will affect the substrate in several ways. Approximately 4,260 square feet of near-shore, shallow-water benthic habitat will be sealed off by installation of 200 linear feet of sheet pile. Approximately 158 cu yd of material will be removed from the stream bottom within the pump station. Then approximately 158 cu yd of concrete will be tremied inside the sheet pile to create a hard bottom. The installation of 11 new intake screen assemblies, including 11 60-inch-diameter pipes and 44 8-inch-diameter micropiles, will disrupt 0.04 acres of substrate. Increased turbidity from project activities will result in sediment deposition, which has the potential to adversely affect primary and secondary productivity (Spence et al. 1996). Excess fine sediment in the action area is expected to be washed away by the next high flow event. Overall, the project will harden and alter 0.14 acres of substrate in the John Day Reservoir. The scale of impact will be minimal relative to the rearing habitat in the action area, and will not change the conservation value of substrate within the John Day Reservoir or at the fifth-field watershed scale.

Water Quality

The proposed action will have a short-term (2 to 3 months) negative effect on water quality by increasing suspended sediment and turbidity during construction and for a short period after construction activities. NMFS anticipates any excess turbidity will dilute and disperse with the river current and not be distinguishable from background levels 500 feet downstream of the proposed action. The use of heavy equipment may result in small amounts of pollutants entering waterways as discussed above. However, it is unlikely chemical contamination will have more than a minimal effect. Given the proposed best management practices, an SPCC plan, and the timing of the elevated turbidity, NMFS believes that the effects to water quality will not meaningfully decrease the function of the PBFs in the action area.

Forage

The proposed action will have a short-term negative effect on benthic macroinvertebrates by crushing, covering, or displacing them during excavation and installation of the sheet wall, intake screens and pipes, micropiles, and cement bottom in an area approximately 0.14 acres. The alteration of this amount of habitat could have some localized effects to forage for out-migrating

and rearing juvenile salmonids and steelhead that use this nearshore areas during construction, and for the first year after project completion. However, forage prey will recolonize the area within a few months after project completion. Given the size of the reservoir, the amount of available local nearshore habitat, and the short-term nature of the action, NMFS does not anticipate that this project will change the conservation value of forage in the John Day Reservoir or at the fifth-field watershed scale.

Safe Passage

NMFS anticipates the proposed action will affect all species and life stages by new permanent in-water structures and increases in piscine predators. Salmon and steelhead migrate through the area as adults and juveniles. Project construction is scheduled at the time of year when the fewest fish are anticipated to migrate through the river corridor. The new structures will alter the quality of the migratory habitat in the nearshore for a portion of the salmon and steelhead that use this area for rearing or foraging. However, adults and juveniles will be able to swim over and around the screen assemblies and around the pump station, and the effects on free passage are expected to be minimal.

Bass and northern pikeminnow are predators on juvenile salmonids. To the extent that the temporary over-water and permanent in-water structures increase bass and pikeminnow predation success, the proposed action could minimally reduce juvenile salmon and steelhead passage success.

Relevance of Effects on Physical or Biological Features to Conservation Value

As described above, the proposed action will have some short-term and long-term effects on substrate, water quality, forage, and safe passage. The persistence of in-water structures will burden the function of the rearing and migration PBFs in the action area. Overall, the proposed action is expected to maintain habitat conditions, but will still allow certain small and degrading actions to continue and persist into the future. These negative effects, however, are minimal in the action area and even less consequential at the HUC5 watershed scale. Therefore, the proposed action will not affect the conservation value of critical habitat at the HUC 5 watershed scale more than a very small amount.

2.6. Cumulative Effects

"Cumulative effects" are those effects of future state or private activities, not involving federal activities, that are reasonably certain to occur within the action area of the federal action subject to consultation (50 CFR 402.02 and 402.17(a)). Future federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA.

Some continuing non-federal activities are reasonably certain to contribute to climate effects within the action area. However, it is difficult if not impossible to distinguish between the action area's future environmental conditions caused by global climate change that are properly part of the environmental baseline versus cumulative effects. Therefore, all relevant future climate-

related environmental conditions in the action area are described in the environmental baseline (Section 2.4).

During this consultation, NMFS searched for information on future state, tribal, local, or private actions that were reasonably certain to occur in the action area. Resource-based activities such as timber harvest, agriculture (including substantial irrigation withdrawals affecting both tributary and mainstem Columbia River flows), mining, shipping, and energy development are likely to continue to exert an influence on the quality of freshwater habitat in the action area. Irrigation of farmlands contributes to large amounts of instream water withdrawals throughout the basin. Applications of pesticides and chemicals for agricultural production contribute to pollutant inputs and accumulate to degrade water quality. Additional effects to the Middle Columbia River are anticipated with population growth, urban development, and increases in recreational use of the Columbia River. The population of Benton County, Washington grew 1.61 percent between 2016 and 2017, and 2.2 percent between 2018 and 2019. NMFS assumes that the population for Benton County will continue to grow for the foreseeable future. As the human population in the action area grows, demand for agricultural, commercial, or residential development, and recreation is likely to increase as well. Industrial and commercial developments contribute to increases in shoreline riprap, altered landscapes and increases in impermeable surfaces. The effects of new development are likely to reduce the conservation value of the habitat within the action area. However, the magnitude of the effect is difficult to predict and is dependent on many social and economic factors. NMFS is not aware of any specific future non-federal activities within the action area that would cause greater effects to a listed species or designated critical habitat than presently occur. However, the adoption of industry-wide standards to reduce environmental impacts and the shift away from resource extraction to a mixed manufacturing and technology-based economy should result in a gradual decrease in influence over time.

When these influences are considered collectively, we expect trends in habitat quality to remain flat or improve gradually over time. This will positively influence population A&P for the species affected by proposed action. In a worst-case scenario, cumulative effects, when balanced with expected federally-sponsored recovery actions, will not have an aggregate effect on population abundance trends. Similarly, we expect the quality and function of critical habitat PBFs to express a slightly positive to neutral trend over time as a result of the cumulative effects and anticipated federally-mandated recovery actions. However, as most activities waterward of the OHWM, whether for recovery or other uses, require a Corps permit, NMFS anticipates that most actions will require some future ESA consultation. In addition, most future state or tribal actions would likely have some form of federal funding or authorization and therefore would also be reviewed by NMFS. This limits the scope of cumulative effects that can be factored in this analysis.

2.7. Integration and Synthesis

The Integration and Synthesis section is the final step in our assessment of the risk posed to species and critical habitat as a result of implementing the proposed action. In this section we add the effects of the action (Section 2.5) to the environmental baseline (Section 2.4) and the cumulative effects (Section 2.6), taking into account the status of the species and critical habitat (Section 2.2), to formulate the agency's biological opinion as to whether the proposed action is likely to: (1) reduce appreciably the likelihood of both the survival and recovery of a listed

species in the wild by reducing its numbers, reproduction, or distribution; or (2) appreciably diminish the value of designated or proposed critical habitat as a whole for the conservation of the species.

The environmental baseline is characterized by degraded floodplain and channel structure, altered sediment routing, altered hydrology, and altered water quality. Within the action area and the HUC5 watershed as a whole, the major sources of impacts to salmon, steelhead, and their critical habitat are hydropower dams as well as the continued development and maintenance of the shoreline including marinas, docks, roads, railroads, and riprap. Dams and reservoirs within the currently accessible migratory corridor have altered the river environment and affected fish passage. The operation of water storage projects has altered the natural hydrograph of many rivers. Water impoundment and dam operations affect downstream water quality characteristics. Salmon and steelhead are exposed to high rates of natural predation during all life stages from fish, birds, and marine mammals. Avian and introduced fish predation on salmonids has been exacerbated by environmental changes associated with river developments. Shoreline development has reduced the quality of nearshore salmon and steelhead habitat by eliminating native riparian vegetation, displacing shallow water habitat with fill materials and by further disconnecting the Columbia River from historic floodplain areas. Further, riparian species that evolved under the environmental gradients of riverine ecosystems are not well suited to the present hydraulic setting of the action area (i.e., static, slackwater pools), and are thus often replaced by non-native species. The riparian system is fragmented, poorly connected, and provides inadequate protection of habitats and refugia for sensitive aquatic species. The cumulative effects of state and private actions within the action area are anticipated to continue at approximately the same level that they are now occurring.

Species

The action area is used by UCR spring-run Chinook salmon, UCR steelhead, MCR steelhead, SRB steelhead, SR spring/summer-run Chinook salmon, SR fall-run Chinook salmon, and SR sockeye salmon. Upper Columbia River spring-run Chinook salmon and SR sockeye are listed as endangered. All three UCR spring-run Chinook salmon populations, and SR sockeye salmon, have an overall viability rating of high risk. The other five species are listed as threatened. Of the 28 extant SR spring/summer-run Chinook salmon populations, 27 have an overall viability rating of high risk, and one population is considered maintained. The lower mainstem population of SR fall-run Chinook salmon has an overall viability rating of moderate risk. Three of the four UCR steelhead populations have an overall viability rating of high risk, and one population is maintained. One SRB steelhead population is rated highly viable and one population is viable, two populations have an overall viability risk of medium, four are rated at high risk, and 16 populations are rated as maintained. Of the 17 extant MCR steelhead populations, one population is highly viable and five are viable, six are maintained, one is at medium risk, and four are at high risk.

NMFS anticipates the proposed action will affect all species and life stages by new permanent in-water structures and increases in piscivorous predators. The project will cause minor, short-term negative effects as a result of project construction (pile driving, excavation, and water quality), with some long-term effects resulting from the new in-water structures, increased

predation, and altered benthic habitat. The proposed action is reasonably likely to have the following effects on the ESA-listed salmon and steelhead covered in this opinion: (1) temporary exposure to elevated TSS and turbidity; (2) increased risk of exposure to toxic contamination; (3) temporary exposure to increased sound levels from pile driving; (4) small losses of benthic habitat and prey base; (5) increased risk of predation from piscivorous fish; and (6) disturbance and displacement from sheet pile, micropile, steel pipe, and screen installation, and barge movements.

Considering the effects of the action in conjunction with the existing condition of the environmental baseline and the small level of potential cumulative effects, NMFS has determined that the loss of a very small number of juvenile salmon and steelhead that may be caused by the proposed action will not be substantial enough to negatively influence VSP criteria at the population scale and should not appreciably reduce the likelihood of any population maintaining its current status. Because the effects will not be substantial enough to negatively influence VSP criteria at the population scale, the viability of MPGs, ESUs, and DPSs are also not expected to be reduced. The effects of the proposed action are not likely to reduce survival of any of the seven species considered in this opinion at the species level. Nor is the action likely to reduce the likelihood of recovery of these species.

Critical Habitat

The proposed action has the potential to affect numerous PBFs within the action area. Those PBFs include water quality (sediment, turbidity, and chemical contamination), substrate, safe passage, and forage. The action's negative effects consist of both short-term and long-term effects that will have a sustained and additive detrimental effect on habitat condition in the mainstem Columbia River. NMFS expects adverse effects to the above PBFs for ESA-listed salmonids from installation of permanent in-water structures and loss of near-shore, shallow-water benthic habitat. Increases in TSS and turbidity during project construction are expected to be small and persist only for a few months. Permanent in-water structures will modify and eliminate benthic habitat, alter passage, decrease forage, and likely increase piscivorous predators in the action area. Forage prey will recolonize disturbed areas with a few months, and will be eliminated from only a very small area of the John Day Reservoir. The effect of the increased number of predators on free passage are expected to be minimal. Based on our analysis, adverse effects from the proposed action will cause a small and localized decline in the quality and function of PBFs in the action area. However, because the short-term and long-term negative effects will not appreciably impair the function of critical habitat (CH), NMFS anticipates that the project as a whole will maintain the overall carrying capacity for migrating and rearing adult and juvenile fish.

For the reasons set out above with respect to the subject species, considering the potential effects of the proposed action with the baseline conditions, potential effects of climate change, and the small level of potential cumulative effects in the action area, NMFS concludes that the proposed action is not expected to appreciably reduce the conservation value of the CH in the action area or at the HUC 5 watershed scale. Because the conservation value of CH in the watershed will not be appreciably reduced, the conservation value of CH at the designation scale will also not be appreciably reduced.

2.8. Conclusion

After reviewing and analyzing the current status of the listed species and critical habitat, the environmental baseline within the action area, the effects of the proposed action, the effects of other activities caused by the proposed action, and cumulative effects, it is NMFS' biological opinion that the proposed action is not likely to jeopardize the continued existence of, or destroy or adversely modify the designated critical habitat of, the following seven species considered in this opinion:

- Upper Columbia River spring-run Chinook salmon
- Snake River spring/summer-run Chinook salmon
- Snake River fall-run Chinook salmon
- Middle Columbia River steelhead
- Upper Columbia River steelhead
- Snake River Basin steelhead
- Snake River sockeye

2.9. Incidental Take Statement

Section 9 of the ESA and federal regulations pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without a special exemption. "Take" is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. "Harm" is further defined by regulation to include significant habitat modification or degradation that actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including breeding, spawning, rearing, migrating, feeding, or sheltering (50 CFR 222.102). "Incidental take" is defined by regulation as takings that result from, but are not the purpose of, carrying out an otherwise lawful activity conducted by the federal agency or applicant (50 CFR 402.02). Section 7(b)(4) and section 7(o)(2) provide that taking that is incidental to an otherwise lawful agency action is not considered to be prohibited taking under the ESA if that action is performed in compliance with the terms and conditions of this ITS.

2.9.1 Amount or Extent of Take

In this biological opinion, NMFS determined that incidental take is reasonably certain to occur and will include harm and harassment caused by the following: (1) behavioral changes due to increased turbidity; (2) behavioral changes due to hydroacoustic effects; (3) benthic habitat loss; and (4) increased predation. NMFS is reasonably certain the incidental take described here will occur because: (1) recent, and historical surveys indicate ESA-listed species are known to occur in the action area; and (2) the proposed action includes instream work activities that could harm or kill juvenile steelhead (pile driving and construction of permanent in-water structures).

Incidental Take from Increased Turbidity

NMFS expects salmon and steelhead to be temporarily displaced due to elevated turbidity levels resulting from in-stream work associated with installation of sheet piles and intake screen assemblies. Because it is not feasible to observe fish fleeing the area, NMFS will use the extent

and duration of the turbidity plume as a surrogate for take resulting from degraded water quality. These indicators are causally linked to incidental take from sheet pile and intake screen assembly installation in streams containing the seven species covered in this opinion, because the amount of take increases as turbidity increases in extent and duration. Therefore, NMFS will consider the extent of take exceeded if turbidity plumes during project construction extend further than 500 feet downstream for more than 60 consecutive minutes.

Incidental Take from Hydroacoustic Effects

Pile driving of sheet pile wall using a vibratory hammer will create hydroacoustic disturbance to ESA-listed fish present in the action area, and alter salmon and steelhead rearing and migration behavior. Some fish will likely flee the immediate area. Because it is not feasible to observe fish fleeing the area, NMFS will use the cumulative duration of peak underwater noise from pile-driving as a surrogate for take. This indicator is causally linked to incidental take from sheet pile installation for the subject species because the amount of take increases as the duration of underwater sound and vibration increases. Therefore, NMFS will consider the extent of take exceeded if the duration of pile driving exceeds 32 hours (approximately 4 days and 50 linear feet per day).

Incidental Take from Benthic Habitat Loss

Changes in benthic habitat can alter a variety of physical processes, which in turn affect fish behavior and fish condition. Estimating the specific number of animals injured or killed by habitat-modifying activities is not possible because of the range of responses that individual fish will have to changed habitat, and because the numbers of fish present at any time, and over time, is highly variable. While this uncertainty makes it impossible to quantify take in terms of numbers of animals injured or killed, the extent of habitat change to which present and future generations of fish will be exposed is readily discernible and presents a reliable measure of the extent of take that can be monitored and tracked. Because the specific number of individuals "harmed" or "harassed" from benthic habitat loss cannot be predicted, NMFS will quantify take based on the extent of habitat modified. Therefore, NMFS will consider the extent of take exceeded if more than 0.14 acres of benthic habitat is altered (4,260 square feet within sheet pile, and 1,815 square feet altered by installation of 11 intake screen assemblies).

Incidental Take from Increased Predation

NMFS anticipates the proposed action will result in harm or harassment to all species and life stages by new permanent in-water structures and increases in piscine predators. Estimating the specific number of animals injured or killed by increased predation is not possible because of the range of responses that individual fish will have, and because the numbers of fish present at any time, and over time, is highly variable. While this uncertainty makes it impossible to quantify take in terms of numbers of animals injured or killed, the extent of habitat change to which present and future generations of fish will be exposed is readily discernible and presents a reliable measure of the extent of take that can be monitored and tracked. Therefore, the estimated extent of habitat modified by the addition of permanent in-water structures represents the extent of take exempted from increased predation in this ITS. The proposed surrogate is causally linked

to anticipated take because it describes conditions that will cause take due to increases in predator habitat. Also, this clearly quantifiable measure can easily be measured to determine if take might be exceeded. Specifically, NMFS will consider extent of take exceeded if the amount of modified habitat, equivalent to the area of new, permanent in-water structure, exceeds 3,465 square feet.

Although these surrogates could be considered coextensive with the proposed action, monitoring and reporting requirements will provide opportunities to check throughout the course of the proposed action whether the surrogates are exceeded. For this reason, the surrogates function as effective reinitiation triggers.

The effects of diverting water in compliance with the Washington Department of Ecology permits are not analyzed in this opinion. Because the diversion of water at this location is an ongoing non-federal activity that does not depend on the proposed action, effects on flow from operating these diversions are outside the scope of this analysis. Any take that might occur as a result of flow depletion or future water withdrawals is not exempted from take prohibition by this incidental take statement.

2.9.2 Effect of the Take

In the biological opinion, NMFS determined that the amount or extent of anticipated take, coupled with other effects of the proposed action, is not likely to result in jeopardy to the species or destruction or adverse modification of critical habitat.

2.9.3 Reasonable and Prudent Measures

"Reasonable and prudent measures" are nondiscretionary measures that are necessary or appropriate to minimize the impact of the amount or extent of incidental take (50 CFR 402.02).

The Corps shall:

1. Avoid or minimize take due to construction activities.
2. Avoid or minimize take from new in- and over-water structures.
3. Avoid or minimize take from reduced water quality.
4. Conduct sufficient monitoring to ensure that the project is implemented as proposed, and the amount and extent of take is not exceeded.

NMFS believes that full application of conservation measures included as part of the proposed action, together with use of the RPMs and terms and conditions described below, are necessary and appropriate to minimize the likelihood of incidental take of listed species due to completion of the proposed action.

2.9.4 Terms and Conditions

The terms and conditions described below are nondiscretionary, and the Corps or any applicant must comply with them in order to implement the RPMs (50 CFR 402.14). The Corps or any applicant has a continuing duty to monitor the impacts of incidental take and must report the progress of the action and its impact on the species as specified in this ITS (50 CFR 402.14). If the entity to whom a term and condition is directed does not comply with the following terms and conditions, protective coverage for the proposed action would likely lapse.

1. To implement RPM 1 (minimize take from construction activities) the Corps shall:
    a. Conduct all work below the OHWM within as short a period as possible between January 1 and February 28.
    b. Confine all impacts to the minimum area necessary to achieve project goals.
    c. Implement all proposed impact minimization measures and Best Management Practices (BMPs) as described in the Proposed Action section of this opinion and in the BA dated November 2019.
    d. Install all sheet piles using a vibratory hammer.
    e. Require 12 hours of non-pile-driving time overnight prior to each day's pile driving activities to minimize cumulative effects.
    f. Herd fish from pump station prior to installing and closing off sheet pile wall.
    g. Post prominently at the worksite the following notice:

    NOTICE: If a sick, injured or dead specimen of a threatened or endangered species is found in the action area, the finder must notify NMFS Law Enforcement at (206) 526-6133 or (800) 853-1964, through the contact person identified in the transmittal letter for this opinion, or through the NMFS Washington State Habitat Office. The finder must take care in handling sick or injured specimens to ensure effective treatment, and in handling dead specimens to preserve biological material in the best possible condition for later analysis of cause of death. The finder should carry out instructions provided by Law Enforcement to ensure evidence intrinsic to the specimen is not disturbed unnecessarily.

2. To implement RPM 2 (minimize take from in-water and over-water structures), the Corps shall remove the barge from the action area as soon as project construction is completed.

3. To implement RPM 3 (minimize take from reduced water quality) the Corps shall:
    a. Conduct turbidity monitoring as follows:
        i. All in-water construction and pile-driving shall be conducted to minimize sedimentation and turbidity in the Columbia River.
        ii. Monitoring will be conducted daily, every 4 hours during daylight hours, when in-water work is conducted.
        iii. Observations shall occur daily before, during, and after commencement of construction activities and compared to observable sediment load upstream of the action area.
        iv. Background measurements will be measured or observed at an undisturbed site within the flow channel approximately 100 feet upstream of the project area.

v. Compliance measures will be measured or observed in the flowing channel approximately 500 feet downstream from the project area, or within any visible turbidity plume.

vi. If visible plume is observed at 500 feet downstream, measurements should not exceed above 10 percent of the background measurements. If there is exceedance, best management practices will be modified and sediment turbidity curtains will be installed to minimize downstream increase of turbidity and fine sediments. Properly sized curtains will be used to ensure that the curtains remain in constant contact with the substrate, span the entire water column, and are sized with appropriate mesh to prevent fish entrainment. Monitoring will be continued every 4 hours. If plume is observed after 8 hours, work shall be stopped for the remainder of the 24-hour day.

b. Vehicles must be fueled, operated, maintained, and stored as follows:

i. Vehicle staging, cleaning, maintenance, refueling, and fuel storage must take place in a vehicle staging area 150 feet or more from any stream, waterbody or wetland, or on an adjacent, established road area.

ii. All vehicles operated within 150 feet of any stream, waterbody or wetland must be inspected daily for fluid leaks before leaving the vehicle staging area. Any leaks detected must be repaired in the vehicle staging area before the vehicle resumes operation. Inspections must be documented in a record that is available for review on request by NMFS.

iii. All equipment operated must be cleaned before beginning operations to remove all external oil, grease, dirt, and mud.

c. A chemical and pollution control plan will be prepared and carried out, commensurate with the scope of the project, which includes:

i. The name, phone number, and address of the person responsible for accomplishing the plan.

ii. Best management practices to confine, remove, and dispose of construction waste, including every type of debris, discharge water, concrete, petroleum product, or other hazardous materials generated, used, or stored on-site including notification of proper authorities.

iii. Procedures to contain and control a spill of any hazardous material generated, used or stored onsite, including notification of proper authorities.

iv. Steps to cease work under high flow conditions, except for efforts to avoid or minimize resource damage.

4. To implement RPM 4 (monitor and reporting) the Corps shall:

a. Track and monitor construction activities to ensure that the conservation measures are meeting the objective of minimizing take. Monitoring shall be conducted by the permittee and include a daily visual survey for fish in the nearshore area inside the in-water work area.

b. Submit a completion of project report to NMFS 2 months after project completion. The completion report shall include, at a minimum, the following:

i. Starting and ending dates for work completed, with in-water work period specified.
ii. Size and maximum surface area that is covered by structures.
iii. Piling type, number, size and linear feet installed.
iv. A log of the dates, start and stop time, and total duration of all vibratory pile installations.
v. Any daily observed sediment plume from the in-channel work area to 500 feet downstream during the in-water construction period. Observations shall occur daily both before during and after commencement of construction activities and compared to observable sediment load upstream of the action area.
vi. Description of the visually monitored downstream extent of turbidity plumes resulting from in-water construction and pile-driving activities.
vii. A summary of pollution and erosion control inspection results, including results of implementing required BMPs, and including a description of any erosion control failure, contaminant release, and efforts to correct such incidences.
viii. Fish herding method, number of listed salmon and steelhead herded from the pump station, and any observed injury or mortality.
ix. Number and species of fish observed injured or killed in the Columbia River.
x. Photos of habitat conditions (open water including structures, shoreline, banks, vegetation, etc.) at the in-water work site before, during, and after project completion. General views and close-ups showing details of the project and project area, including pre- and post-construction. Label each photo with date, time, project name, photographer's name, and the subject.
xi. Reference to NMFS consultation number WCRO-2019-03621.

c. All reports will be sent to:

National Marine Fisheries Service
Columbia Basin Branch
304 South Water Street, Suite 201
Ellensburg, Washington 98926

d. If the amount or extent of take is exceeded, stop project activities and notify NMFS immediately.

2.10. Conservation Recommendations

Section 7(a)(1) of the ESA directs federal agencies to use their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of the threatened and endangered species. Specifically, conservation recommendations are suggestions regarding discretionary measures to minimize or avoid adverse effects of a proposed action on listed species or critical habitat or regarding the development of information (50 CFR 402.02).

The following conservation recommendations are discretionary measures that NMFS believes are consistent with this obligation and therefore should be carried out by the federal action agency:

1. To mitigate the effects of climate change on ESA-listed salmonids, follow recommendations by the ISAB (2007) to plan now for future climate conditions by

implementing protective tributary, mainstem, and estuarine habitat measures, as well as protective hydropower mitigation measures. In particular, implement measures to protect or restore riparian buffers, wetlands, and floodplains, to remove stream barriers, and to ensure late summer and fall tributary streamflows.

2. Coordinate and work with applicants, property owners, stakeholders and other entities to improve and restore shoreline conditions to more natural riverbanks along the developed and altered banks of the Columbia River mainstem upstream and downstream of the action area. Such efforts may improve near shore conditions and increase habitat complexity to benefit fisheries and aquatic resources.
3. Work with private entities and other landowners on long-term plans and designs to improve water use and efficiency, and to upgrade and modify other existing pump stations and intakes to prevent injury to fish and aquatic resources.

2.11. Reinitiation of Consultation

This concludes formal consultation for the AgriNorthwest Intake Screen Replacement Project.

As 50 CFR 402.16 states, reinitiation of consultation is required and shall be requested by the federal agency or by NMFS where discretionary federal agency involvement or control over the action has been retained or is authorized by law and if (1) the amount or extent of incidental taking specified in the ITS is exceeded, (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion, (3) the identified action is subsequently modified in a manner that causes an effect to the listed species or critical habitat that was not considered in the biological opinion, or (4) a new species is listed or critical habitat designated that may be affected by the action.

3. MAGNUSON-STEVENS FISHERY CONSERVATION AND MANAGEMENT ACT ESSENTIAL FISH HABITAT RESPONSE

Section 305(b) of the MSA directs federal agencies to consult with NMFS on all actions or proposed actions that may adversely affect EFH. The MSA (section 3) defines EFH as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." Adverse effect means any impact that reduces quality or quantity of EFH, and may include direct or indirect physical, chemical, or biological alteration of the waters or substrate and loss of (or injury to) benthic organisms, prey species and their habitat, and other ecosystem components, if such modifications reduce the quality or quantity of EFH. Adverse effects on EFH may result from actions occurring within EFH or outside of it and may include site-specific or EFH-wide impacts, including individual, cumulative, or synergistic consequences of actions (50 CFR 600.810). Section 305(b) also requires NMFS to recommend measures that can be taken by the action agency to conserve EFH.

This analysis is based, in part, on the EFH assessment provided by the Corps and descriptions of EFH for Pacific Coast salmon (PFMC 2014) contained in the fishery management plans developed by the PFMC and approved by the Secretary of Commerce.

3.1. Essential Fish Habitat Affected by the Project

The proposed project action area includes EFH for various life-history stages of Chinook salmon (*O. tshawytscha*) and coho salmon (*O. kitsutch*) (PFMC 2014).

3.2. Adverse Effects on Essential Fish Habitat

Based on information provided in the BA and the analysis of effects presented in Section 2 of this document, NMFS concludes that the proposed action will adversely affect EFH designated for Chinook and coho salmon because it will have effects on water quality, benthic communities, and habitat connectivity.

The proposed project includes adding 2,800 square feet of temporary over-water structure (barge), installing 200 linear feet of sheet pile, 11 new intake screens (1,650 square feet), 11 steel 60-inch-diameter intake pipes (1,800 square feet), 44 8-inch-diameter micropiles (15.5 square feet) piles, and closing off 4,260 square feet within the pump station. This will alter approximately 0.18 acres of river bottom, altering benthic habitat and macroinvertebrate production. The action will result in permanent new in-water structures in the Columbia River, which will impair the quality of habitat. These changes to EFH are long-lasting effects.

Specifically, NMFS has determined that the action will adversely affect EFH as follows:

1. The permanent alteration of the near-shore environment by placement of in-water structures which will affect juvenile rearing and the juvenile migration corridor.
2. Temporary reduction in prey availability from removal and disturbance of the macroinvertebrate community and as a result of increased fine sediment in stream substrates due to instream work.
3. Reduction of established streambed substrates and loss of shallow-water habitat from disturbance of native substrates.
4. Short-term elevation of turbidity and sedimentation within and immediately upstream and downstream from the construction area from construction activities and construction materials.
5. Short-term, degraded water quality due to slight chemical contamination from heavy equipment working in the river.
6. Habitat disturbance due to vibratory pile driving (hydroacoustic impacts). Vibratory pile driving sound will alter the physical properties of the habitat, reducing the quality of the habitat in the action area.

3.3. Essential Fish Habitat Conservation Recommendations

We provide the following conservation recommendation:

1. Implement RPM 1 and RPM 3, and their terms and conditions described in the ITS in the ESA portion of this document, to minimize adverse effects to EFH due to pile driving, operation of heavy equipment, and sediment disturbance.
2. Implement RPM 4, and its terms and conditions described in the ITS in the ESA portion of this document, to ensure completion of monitoring and reporting to confirm that these terms and conditions are effective for avoiding and minimizing adverse effects to EFH.

Fully implementing these EFH conservation recommendations would protect, by avoiding or minimizing the adverse effects described in Section 3.2 above, approximately 0.18 acres of designated EFH for Pacific Coast salmon.

3.4. Statutory Response Requirement

As required by section 305(b)(4)(B) of the MSA, the Corps must provide a detailed response in writing to NMFS within 30 days after receiving an EFH Conservation Recommendation. Such a response must be provided at least 10 days prior to final approval of the action if the response is inconsistent with any of NMFS' EFH Conservation Recommendations unless NMFS and the federal agency have agreed to use alternative timeframes for the federal agency response. The response must include a description of measures proposed by the agency for avoiding, minimizing, mitigating, or otherwise offsetting the impact of the activity on EFH. In the case of a response that is inconsistent with the Conservation Recommendations, the federal agency must explain its reasons for not following the recommendations, including the scientific justification for any disagreements with NMFS over the anticipated effects of the action and the measures needed to avoid, minimize, mitigate, or offset such effects (50 CFR 600.920(k)(1)).

In response to increased oversight of overall EFH program effectiveness by the Office of Management and Budget, NMFS established a quarterly reporting requirement to determine how many conservation recommendations are provided as part of each EFH consultation and how many are adopted by the action agency. Therefore, we ask that in your statutory reply to the EFH portion of this consultation you clearly identify the number of conservation recommendations accepted.

3.5. Supplemental Consultation

The Corps must reinitiate EFH consultation with NMFS if the proposed action is substantially revised in a way that may adversely affect EFH, or if new information becomes available that affects the basis for NMFS' EFH Conservation Recommendations (50 CFR 600.920(l)).

4. Data Quality Act Documentation and Pre-Dissemination Review

The Data Quality Act specifies three components contributing to the quality of a document. They are utility, integrity, and objectivity. This section of the opinion addresses these DQA components, documents compliance with the DQA, and certifies that this opinion has undergone pre-dissemination review.

4.1. Utility

Utility principally refers to ensuring that the information contained in this consultation is helpful, serviceable, and beneficial to the intended users. The intended user of this opinion is the Corps. Other interested users could include AgriNorthwest, the citizens of Benton County, J-U-B Engineers, Inc., and Environmental Assessment Services, LLC. Individual copies of this opinion were provided to the Corps. The document will be available within 2 weeks at the NOAA Library Institutional Repository [https://repository.library.noaa.gov/welcome]. The format and naming adheres to conventional standards for style.

4.2. Integrity

This consultation was completed on a computer system managed by NMFS in accordance with relevant information technology security policies and standards set out in Appendix III, 'Security of Automated Information Resources,' Office of Management and Budget Circular A-130; the Computer Security Act; and the Government Information Security Reform Act.

4.3. Objectivity

Information Product Category: Natural Resource Plan

Standards: This consultation and supporting documents are clear, concise, complete, and unbiased; and were developed using commonly accepted scientific research methods. They adhere to published standards including the NMFS ESA Consultation Handbook, ESA regulations, 50 CFR 402.01 et seq., and the MSA implementing regulations regarding EFH, 50 CFR 600.

Best Available Information: This consultation and supporting documents use the best available information, as referenced in the References section. The analyses in this opinion and EFH consultation contain more background on information sources and quality.

Referencing: All supporting materials, information, data and analyses are properly referenced, consistent with standard scientific referencing style.

Review Process: This consultation was drafted by NMFS staff with training in ESA, and reviewed in accordance with West Coast Region ESA quality control and assurance processes.

5. REFERENCES

Abatzoglou, J. T., D. E. Rupp, and P. W. Mote. 2014. Seasonal climate variability and change in the Pacific Northwest of the United States. Journal of Climate 27(5): 2125–2142.

Barton, B. A., and W. P. Dwyer. 1997. Physiological stress effects of continuous- and pulsed-DC electroshock on juvenile bull trout. Journal of Fish Biology 51: 998–1008.

Barton, A., B. Hales, G. G. Waldbuster, C. Langdon, and R. Feely. 2012. The Pacific Oyster, *Crassostrea gigas*, Shows Negative Correlation to Naturally Elevated Carbon Dioxide Levels: Implications for Near-Term Ocean Acidification Effects. *Limnology and Oceanography* 57 (3): 698–710.

Beeman, J. W., and A. G. Maule. 2006. Migration depths of juvenile Chinook salmon and steelhead relative to total dissolved gas supersaturation in a Columbia River reservoir. Transactions of the American Fisheries Society 135: 584–594.

Berg, L., and T. G. Northcote. 1985. Changes in territorial, gill-flaring, and feeding behavior in juvenile coho salmon (*Oncorhynchus kisutch*) following short-term pulses of suspended sediment. Canadian Journal of Fisheries and Aquatic Sciences 42: 1410–1417.

Bradford, M. J., and G. C. Taylor. 1997. Individual variation in dispersal behavior of newly emerged Chinook salmon (*Oncorhynchus tshawytscha*) from the upper Fraser River, British Columbia. Canadian Journal of Fisheries and Aquatic Sciences 54(7): 1585–1592.

California Department of Transportation. 2009. Technical guidance for assessment and mitigation of the hydroacoustic effects of pile driving on fish. Sacramento, California.

Celedonia, M. T., R. A. Tabor, S. Sanders, S. Damm, D. W. Lantz, T. M. Lee, Z. Li, J. M. Pratt, B. E. Price, and L. Seyda. 2008. Movement and habitat use of Chinook salmon smolts, Northern pikeminnow, and smallmouth bass near the SR 520 bridge, 2007 acoustic tracking study. Lacey, Washington, U.S. Fish and Wildlife Service, Western Washington Fish and Wildlife Office Fisheries Division: 125.

Chapman, D. W. 2007. Effects of docks in Wells Dam Pool on subyearling summer/fall Chinook salmon. Douglas County Public Utility District.

Columbia Basin Research. 2013. Columbia River DART. From http://www.cbr.washington.edu/dart/dart.html.

Connor, W. P., A. R. Marshall, T. C. Bjornn, and H. L. Burge. 2001. Growth and long-range dispersal by wild subyearling spring and summer Chinook salmon in the Snake River basin. Transactions of the American Fisheries Society 130(6): 1070–1076.

Crozier, L. G., A. P. Hendry, P. W. Lawson, T. P. Quinn, N. J. Mantua, J. Battin, R. G. Shaw, and R. B. Huey. 2008. Potential responses to climate change for organisms with complex life histories: evolution and plasticity in Pacific salmon. Evolutionary Applications 1(1): 252–270.

Crozier, L. G., M. D. Scheuerell, and R. W. Zabel. 2011. Using time series analysis to characterize evolutionary and plastic responses to environmental change: a case study of a shift toward earlier migration date in sockeye salmon. American Naturalist 178: 755–773.

Dauble, D., T. L. Page, and R. W. Hanf. 1989. Spatial distribution of juvenile salmonids in the Hanford Reach, Columbia River. Fishery Bulletin 87: 775–790.

DEQ (Idaho Department of Environmental Quality). 2011. Idaho Department of Environmental Quality final 2010 integrated report. Boise, Idaho.

Dominguez, F., E. Rivera, D. P. Lettenmaier, and C. L. Castro. 2012. Changes in Winter Precipitation Extremes for the Western United States under a Warmer Climate as Simulated by Regional Climate Models. Geophysical Research Letters 39(5).

Doney, S. C., M. Ruckelshaus, J. E. Duffy, J. P. Barry, F. Chan, C. A. English, H. M. Galindo, J. M. Grebmeier, A. B. Hollowed, N. Knowlton, J. Polovina, N. N. Rabalais, W. J. Sydeman, and L. D. Talley. 2012. Climate Change Impacts on Marine Ecosystems. Annual Review of Marine Science 4: 11–37.

Feely, R. A., T. Klinger, J. A. Newton, and M. Chadsey (eds.) 2012. Scientific summary of ocean acidification in Washington State marine waters. Washington Shellfish Initiative Blue Ribbon Panel on Ocean Acidification. NOAA Office of Atmospheric Research Special Report. Contribution No. 3934 from NOAA/Pacific Marine Environmental Laboratory, Seattle.

Fowler, R. T. 2004. The recovery of benthic invertebrate communities following dewatering in two braided rivers. Hydrobiologia 523: 17–28.

Fritts, A. L., and T. N. Pearsons. 2004. Smallmouth bass predation on hatchery and wild salmonids in the Yakima River, Washington. Transactions of the American Fisheries Society 133: 880–895.

Glick, P., J. Clough, and B. Nunley. 2007. Sea-level rise and coastal habitat in the Pacific Northwest: an analysis for Puget Sound, southwestern Washington, and northwestern Oregon. National Wildlife Federation.

Good, T. P., R. S. Waples, and P. Adams. 2005. Updated status of Federally listed ESUs of West Coast salmon and steelhead, U.S. Department of Commerce: 597.

Goode, J. R., J. M. Buffington, D. Tonina, D. J. Isaak, R. F. Thurow, S. Wenger, D. Nagel, C. Luce, D. Tetzlaff, and C. Soulsby. 2013. Potential effects of climate change on streambed scour and risks to salmonid survival in snow-dominated mountain basins. Hydrological Processes 27(5): 750–765.

Gregory, R. S., and C. D. Levings. 1998. Turbidity reduces predation on migrating juvenile pacific salmon. Transactions of the American Fisheries Society 127: 275–285.

Hughes, N. F. 2004. The wave-drag hypothesis: an explanation for size-based lateral segregation during the upstream migration of salmonids. Canadian Journal of Fisheries and Aquatic Science 61: 103–109.

ICTRT (Interior Columbia Basin Technical Recovery Team). 2003. Independent populations of chinook, steelhead, and sockeye for listed evolutionarily significant units within the Interior Columbia River Domain, Northwest Fisheries Science Center.

ICTRT. 2005. Viability criteria for application to Interior Columbia Basin salmonid ESUs, Northwest Fisheries Science Center: 49.

ICTRT. 2007. Viability criteria for application to Interior Columbia Basin salmonid ESUs. Review draft. Interior Columbia Technical Recovery Team, Northwest Fisheries Science Center, National Marine Fisheries Service.

IPCC (Intergovernmental Panel on Climate Change). 2014. Contribution of working groups I, II and III to the fifth assessment report of the intergovernmental panel on climate change [Core Writing Team, R. K. Pachauri and L.A. Meyer (eds.)] IPCC, Geneva, Switzerland.

ISAB (Independent Scientific Advisory Board). 2007. Climate change impacts on Columbia River Basin fish and wildlife, Portland, Oregon.

Johnson, E. L., T. S. Clabough, C. C. Caudill, M. L. Keefer, C. A. Peery, and M. C. Richmond. 2008. Migration depths of adult steelhead *Oncorhynchus mykiss* in relation to dissolved gas supersaturation in a regulated river system. Journal of Fish Biology 76: 1520–1528.

Keefer, M. L., C. A. Peery, and M. J. Heinrich. 2008. Temperature-mediated en route migration mortality and travel rates of endangered Snake River sockeye salmon. Ecology of Freshwater Fish 17(1): 136–145.

Korsu, K. 2004. Response of benthic invertebrates to disturbance from stream restoration: the importance of bryophytes. Hydrobiologia 523: 37–45.

Kunkel, K. E., L. E. Stevens, S. E. Stevens, L. Sun, E. Janssen, D. Wuebbles, K. T. Redmond, and J. G. Dobson. 2013. Regional Climate Trends and Scenarios for the U.S. National Climate Assessment: Part 6. Climate of the Northwest U.S. NOAA Technical Report NESDIS 142-6. 83 pp. National Oceanic and Atmospheric Administration, National Environmental Satellite, Data, and Information Service, Washington, D.C.

Lawson, P. W., E. A. Logerwell, N. J. Mantua, R. C. Francis, and V. N. Agostini. 2004. Environmental factors influencing freshwater survival and smolt production *in:* Pacific Northwest coho salmon (*Oncorhynchus kisutch*). Canadian Journal of Fisheries and Aquatic Sciences 61: 360–373.

Levings, C. D., C. D. McAllister, and B. D. Chang. 1986. Differential use of the Campbell River Estuary, British Columbia, by wild and hatchery reared juvenile Chinook salmon (*Oncorhynchus tshawytscha*). Canadian Journal of Fisheries and Aquatic Sciences 43(7): 1386–1397.

Levy, D. A., and T. G. Northcote. 1982. Juvenile Salmon Residency in a Marsh Area of the Fraser-River Estuary. Canadian Journal of Fisheries and Aquatic Sciences 39(2): 270–276.

Lloyd, D. S., J. P. Koenings, and J. D. Laperriere. 1987. Effects of turbidity in fresh waters of Alaska. North American Journal of Fisheries Management 7: 18–33.

Macdonald, J. S., C. D. Levings, C. D. McAllister, U. H. M. Fagerlund., and J. R. McBride. 1988. A Field Experiment to Test the Importance of Estuaries for Chinook Salmon (*Oncorhynchus tshawytscha*) Survival—Short-Term Results. Canadian Journal of Fisheries and Aquatic Sciences 45(8): 1366–1377.

Mains, E. M., and J. M. Smith. 1964. The distribution size, time and current references of seaward migrant chinook salmon in the Columbia and Snake Rivers. Washington State Department of Fisheries, Fisheries Research Papers 2: 5–43.

Mantua, N., I. Tohver, and A. Hamlet. 2009. Impacts of climate change on key aspects of freshwater salmon habitat in Washington State. Chapter 6 *in* Washington Climate Change Impacts Assessment: Evaluating Washington's future in a changing climate. Climate Impacts Group, University of Washington pp 217–254.

Mantua, N., I. Tohver, and A. Hamlet. 2010. Climate change impacts on streamflow extremes and summertime stream temperature and their possible consequences for freshwater salmon habitat in Washington State. Climate Change 102: 187–233.

Marshall, A. R., H. L. Blankenship, and W. P. Connor. 2000. Genetic characterization of naturally-spawned Snake River fall-run Chinook salmon. Transactions of the American Fisheries Society 129(3): 680–698.

McElhany, P., M. H. Ruckelshaus, M. J. Ford, T. C. Wainwright, and E. P. Bjorkstedt. 2000. Viable salmonid populations and the recovery of evolutionarily significant units, U.S. Department of Congress: 156.

McMahon, T. E., and G. F. Hartman. 1989. Influence of cover complexity and current velocity on winter habitat use by juvenile coho salmon (*Oncorhynchus kisutch*). Canadian Journal of Fisheries and Aquatic Science. 46: 1551–1557.

McClure, M., T. Cooney, and Interior Columbia Technical Recovery Team. 2005. Updated population delineation in the interior Columbia Basin. Memorandum to NMFS NW Regional Office, co-managers and other interested parties. May 11.

Meador, J. P., F. C. Sommers, G. M. Ylitalo, and C. A. Sloan. 2006. Altered growth and related physiological responses in juvenile chinook salmon (*Oncorhynchus tshawytscha*) from dietary exposure to polycyclic aromatic hydrocarbons (PAHs). Canadian Journal of Fisheries and Aquatic Sciences 63: 2364–2376.

Meyer, J. L., M. J. Sale, P. J. Mulholland, and N. L. Poff. 1999. Impacts of climate change on aquatic ecosystem functioning and health. Journal of the American Water Resources Association 35(6): 1373–1386.

Mote, P., A. K. Snover, S. Capalbo, S. D. Eigenbrode, P. Blick, J. Littell, R. R. Raymondi, and W. S. Reeder. 2014. Ch. 21 Northwest. In Climate change impacts in the United States: the third national climate assessment. J. M. Melillo, T. C. Terese, T. C. Richmond, and G. W. Yohe, editors. U.S. Global Change Research Program, pages 487–513.

Mote, P. W., D. E. Rupp, S. Li, D. J. Sharp, F. Otto, P. F. Uhe, M. Xiao, D. P. Lettenmaier, H. Cullen, and M. R. Allen. 2016. Perspectives on the cause of exceptionally low 2015 snowpack in the western United States, Geophysical Research Letters, 43, doi:10.1002/2016GLO69665.

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.

Nightingale, B., and C. Simenstad. 2001. Overwater structures: marine issues, Washington State Department of Fish and Wildlife: 133.

NMFS. 2005. Final assessment of NMFS' critical habitat analytical review reams for 12 evolutionarily significant units of West Coast salmon and steelhead. NMFS, Portland, Oregon.

NMFS. 2007. 2007 Report to Congress, Pacific Coastal Salmon Recovery Fund FY 2000–2006. National Marine Fisheries Service, Seattle.

NMFS. 2008a. Agreement in principle for interim criteria for injury to fish from pile driving activities.

NMFS. 2009. Middle Columbia River Steelhead Distinct Population Segment ESA Recovery Plan. National Marine Fisheries Service, Northwest Region.

NMFS. 2011. Biennial Report to Congress on the Recovery Program for Threatened and Endangered Species October 1, 2008–September 30, 2010. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Washington, D.C.

NMFS. 2015. ESA Recovery Plan for Snake River Sockeye Salmon. West Coast Region, Protected Resources Division, Portland, Oregon.

NMFS. 2016a. 2016 5-Year Review: Summary & Evaluation of Upper Columbia River Steelhead Upper Columbia River Spring-run Chinook Salmon. National Marine Fisheries Service West Coast Region, Portland, Oregon.

NMFS. 2016b. 2016 5-Year Review: Summary & Evaluation of Snake River Sockeye, Snake River Spring-Summer Chinook, Snake River Fall-Run Chinook, Snake River Basin Steelhead. National Marine Fisheries Service, West Coast Region, Portland, Oregon.

NMFS. 2016c. 2016 5-Year Review: Summary & Evaluation of Middle Columbia River Steelhead. National Marine Fisheries Service, West Coast Region, Portland, Oregon.

NMFS. 2017a. ESA Recovery Plan for Snake River Spring/Summer Chinook Salmon and Snake River Steelhead. West Coast Region, Protected Resources Division, Portland, Oregon.

NMFS. 2017b. ESA Recovery for Snake River Fall Chinook Salmon. West Coast Region, Protected Resources Division, Portland, Oregon.

NMFS. 2019. Endangered Species Act (ESA) Section 7(a)(2) Biological Opinion and Magnuson–Stevens Fishery Conservation and Management Act Essential Fish Habitat (EFH) Consultation on the ongoing operation and maintenance of the Columbia River System. NMFS Consultation Number WCR-2018-00152.

NWFSC (Northwest Fisheries Science Center). 2015. Status review update for Pacific salmon and steelhead listed under the Endangered Species Act: Pacific Northwest. Northwest Fisheries Science Center.

ODEQ (Oregon Department of Environmental Quality). 2006. Oregon's 2004/2006 Integrated Report. Portland, Oregon.

ODFW and WDFW (Oregon Department of Fish and Wildlife and Washington Department of Fish and Wildlife). 2020. 2020 Joint staff report: stock status and fisheries for spring Chinook, summer Chinook, sockeye, steelhead, and other species, and miscellaneous regulations. Joint Columbia River Management Staff, 2/07/2020.

PFMC (Pacific Fishery Management Council). 2014. Appendix A to the Pacific Coast Salmon Fishery Management Plan, as modified by Amendment 18 to the Pacific Coast Salmon Plan: Identification and description of essential fish habitat, adverse impacts, and recommended conservation measures for salmon. Pacific Fishery Management Council, Portland, Oregon. September 2014. 196 p. + appendices.

Petersen, J. H., and D.M. Gadomski. 1994. Light-mediated predation by northern squawfish on juvenile Chinook salmon. Journal of Fish Biology 45(supplement A):227–242.

Petersen, J. H, S. T. Sauter, C. N. Frost, S. R. Gray, and T. P. Poe. 1993. Indexing juvenile salmonid consumption by northern squawfish in the Columbia River below Bonneville Dam and in John Day Reservoir, 1992. *In* J. H. Petersen and T. P. Poe, editors. Systemwide Significance of Predation on Juvenile Salmonids in Columbia and Snake River Reservoirs: Annual Report 1992 to Bonneville Power Administration, Portland, Oregon.

Peven, C. M. 1987. Downstream migration timing of two stocks of Sockeye Salmon on the Mid-Columbia River. Northwest Science 61(3): 186–190.

Pribyl, A. L., J. S. Vile, and T. A. Friesen. 2004. Population structure, movement, habitat use, and diet of resident piscivorous fishes in the Lower Willamette River, Oregon Department of Fish and Wildlife: 139–184.

Redding, J. M., C. B. Schreck, and F. H. Everest. 1987. Physiological effects on coho salmon and steelhead of exposure to suspended solids. Transactions of the American Fisheries Society 116: 737–744.

Reeder, W. S., P. R. Ruggiero, S. L. Shafer, A. K. Snover, L. L Houston, P. Glick, J. A. Newton, and S. M Capalbo. 2013. Coasts: Complex Changes Affecting the Northwest's Diverse Shorelines. *In* Climate Change in the Northwest: Implications for Our Landscapes, Waters, and Communities, edited by M. M. Dalton, P. W. Mote, and A. K. Snover, 41–58. Island Press, Washington, D.C.

Rondorf, D. W., G. L. Rutz, and J. C. Charrier. 2010. Minimizing effects of over-water docks on federally listed fish stocks in McNary Reservoir: a literature review for criteria. Cook, Washington, U.S. Geological Survey, Western Fisheries Research Center: 41.

Scheuerell, M. D., and J. G. Williams. 2005. Forecasting climate-induced changes in the survival of Snake River spring/summer Chinook salmon (*Oncorhynchus tshawytscha*). Fisheries Oceanography 14:448–457.

Servizi, J. A., and D. W. Martens. 1991. Effect of temperature, season, and fish size on acute lethal suspended sediments to Coho salmon (*Oncorhynchus kisutch*). Canadian Journal of Fisheries and Aquatic Science 48: 493–497.

Spence, B. C., G. A. Lomnicky, R. M. Hughes, and R. P. Novitzki. 1996. An ecosystem approach to salmonid conservation. ManTech Environmental Research Services Corporation, Corvallis, Oregon.

Stadler, J. H., and D. P. Woodbury. 2009. Assessing the effects to fishes from pile driving: application of new hydroacoustic criteria. Inter-Noise 2009. Ottawa, Canada.

Sunda, W. G., and W. J. Cai. 2012. Eutrophication induced CO2-acidification of subsurface coastal waters: interactive effects of temperature, salinity, and atmospheric CO2. Environmental Science & Technology 46(19): 10651–10659.

Tabor, R. A., G. Brown, and V. T. Luiting. 1998. The effect of light intensity on predation of sockeye salmon fry by prickly sculpin and torrent sculpin. U.S. Fish and Wildlife Service, Western Washington Office, Aquatic Resources Division, Lacey, Washington.

Tabor, R. A., M. T. Celedonia, F. Mejia, R. M. Piaskowski, D. L. Low, B. Footen, and L. Park. 2004. Predation of juvenile Chinook salmon by predatory fishes in three areas of the Lake Washington Basin. Lacey, Washington, U.S. Fish and Wildlife Service: 78.

Tague, C. L., J. S. Choate, and G. Grant. 2013. Parameterizing sub-surface drainage with geology to improve modeling streamflow responses to climate in data limited environments. Hydrology and Earth System Sciences 17(1): 341–354.

Tillmann, P., and D. Siemann. 2011. Climate Change Effects and Adaptation Approaches in Marine and Coastal Ecosystems of the North Pacific Landscape Conservation Cooperative Region. National Wildlife Federation.

Timko, M. A., L. S. Sullivan, R. R. O'Connor, C. D. Wright, S. E. Rizor, J. L. Hannity, C. A. Fitzgerald, M. L. Meagher, J. D. Stephenson, J. R. Skalski, and R. L. Townsend. 2011. Behavior and survival analysis of juvenile steelhead and sockeye salmon through the Priest Rapids Hydroelectric Project in 2010, Public Utility District No. 2 of Grant County.

UCSRB (Upper Columbia Salmon Recovery Board). 2007. Upper Columbia Spring Chinook Salmon and Steelhead Recovery Plan.

USDC (U.S. Department of Commerce). 2013. Endangered and threatened species: Designation of a nonessential experimental population for Middle Columbia River Steelhead above the Pelton Round Butte Hydroelectric Project in the Deschutes River Basin, Oregon. Department of Commerce, National Oceanic and Atmospheric Administration. Federal Register 78(10): 2893–2907.

USDC (U.S. Department of Commerce). 2014. Endangered and threatened wildlife; Final rule to revise the Code of Federal Regulations for species under the jurisdiction of the National Marine Fisheries Service. U.S. Department of Commerce. Federal Register 79(71): 20802–20817.

Vigg, S., T. P. Poe, L. A. Prendergast, and H. C. Hansel. 1991. Rates of consumption of juvenile salmonids and alternative prey fish by northern squawfish, walleyes, smallmouth bass, and channel catfish in John Day Reservoir, Columbia River. Transactions of the American Fisheries Society 120: 421–438.

Wainwright, T. C., and L. A. Weitkamp. 2013. Effects of Climate Change on Oregon Coast Coho Salmon: Habitat and Life-Cycle Interactions. Northwest Science 87: 219–242.

Winder, M., and Daniel E. Schindler. 2004. Climate change uncouples trophic interactions in an aquatic ecosystem. Ecology 85: 2100–2106.

Wissmar, R. C., J. E. Smith, B. A. McIntosh, H. W. Li, G. H. Reeves, and J. R. Sedell. 1994. Ecological health of river basins in forested regions of Eastern Washington and Oregon. U.S. Department of Agriculture, Forest Service, PNW-GTR-326.

Zabel, R. W., M. D. Scheuerell, M. M. McClure, and J. G. Williams. 2006. The interplay between climate variability and density dependence in the population viability of Chinook salmon. Conservation Biology 20(1): 190–200.

Zimmerman, M. P., and D. L. Ward. 1999. Index of predation on juvenile salmonids by northern pikeminnow in the Lower Columbia River Basin, 1994–1996. Transactions of the American Fisheries Society 128: 995–1007.