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-2021-01784

https://doi.org/10.25923/x7mm-kr67

November 17, 2021

William D. Abadie
Chief, Regulatory Branch
U.S. Army Corps of Engineers, Portland District
P.O. Box 2946
Portland, OR 97208-2946

Re: Endangered Species Act Section 7(a)(2) Biological Opinion and Magnuson–Stevens Fishery Conservation and Management Act Essential Fish Habitat Response for the Mayer State Park Boat Launch Facility Improvements Project, (HUC 170701050406), Columbia River, Wasco Country, Oregon.

Dear Mr. Abadie:

Thank you for your letter of July 26, 2021, 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 Mayer State Park Boat Launch Facility Improvements 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.

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 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 steelhead, Snake River Basin steelhead, SR fall-run Chinook salmon, and 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 is providing an incidental take statement (ITS) with the opinion. The ITS includes reasonable and prudent measures (RPMs) NMFS considers necessary or appropriate to minimize the impact of incidental take associated with this action.

The ITS also sets forth terms and conditions, including reporting requirements, that the U.S. Army Corps of Engineers must comply with to carry out the RPMs. Incidental take from actions that meet these terms and conditions will be exempt from the ESA's prohibition against the take of the listed species considered in this opinion.

Please contact Rebecca Viray, Columbia Basin Branch, (541) 962-8524, Rebecca.Viray@noaa.gov, if you have any questions concerning this consultation, or if you require additional information.

Sincerely,

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

Enclosure

cc: Caila Heintz, USACE, Regulatory Office, caila.m.heintz@usace.army.mil
Darrell Monk, OPRD, Darrell.Monk@oregon.gov
Eric Campbell, Campbell Environmental LLC, eric@campbellenviro.com

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

Mayer State Park Boat Launch Facility Improvements Project

NMFS Consultation Number: WCRO-2021-01784

Action Agency: U.S. Army Corps of Engineers

Affected Species and NMFS' Determinations:

ESA-Listed Species	Status	Is Action Likely to Adversely Affect Species or Critical Habitat	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 Chinook salmon (*Oncorhynchus tshawytscha*)	Endangered	Yes	No	Yes	No
Upper Columbia River steelhead (*O. mykiss*)	Threatened	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 sockeye salmon (*O. nerka*)	Endangered	Yes	No	Yes	No
Snake River steelhead (*O. mykiss*)	Threatened	Yes	No	Yes	No
Middle Columbia River 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 I

Michael P. Tehan
Assistant Regional Administrator
Interior Columbia Basin Office
National Marine Fisheries Service

Date: November 17, 2021

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ACRONYM GLOSSARY

A&P	Abundance and Productivity
BA	Biological Assessment
BMP	Best Management Practice
CFR	Code of Federal Regulations
cfs	Cubic Feet per Second
CHART	Critical Habitat Analytical Review Team
Corps	U.S. Army Corps of Engineers
cu yd	Cubic Yard(s)
dB	Decibels
DOC	U.S. Department of Commerce
DPS	Distinct Population Segment
DQA	Data Quality Act
EFH	Essential Fish Habitat
ESA	Endangered Species Act
ESU	Evolutionarily Significant Unit
FHWG	Fisheries Hydroacoustic Working Group
fps	Feet per Second
FR	Federal Register
ft	Feet
ft^2	Square Feet
gpm	Gallons per Minute
hrs	Hours
HUC	Hydrologic Unit Code
ICRD	Interior Columbia Recovery Domain
ICTRT	Interior Columbia Basin Technical Recovery Team
ISAB	Independent Scientific Advisory Board
ITS	Incidental Take Statement
IWWW	In-Water Work Window
kcfs	Kilo Cubic Feet per Second
MCR	Middle Columbia River
MPG	Major Population Group
MSA	Magnuson–Stevens Fishery Conservation and Management Act
NMFS	National Marine Fisheries Service
NTU	Nephelometric Turbidity Unit
NWFSC	Northwest Fisheries Science Center
ODEQ	Oregon Department of Environmental Quality
OHWM	Ordinary High Water Mark
opinion	Biological Opinion
OPRD	Oregon Parks and Recreation Department
PAH	Polycyclic Aromatic Hydrocarbon
Park	Mayer State Park
PBF	Physical or Biological Feature
PCB	Polychlorinated Biphenyl
PCE	Primary Constituent Element
PCP	Pollution Control Plan

RM	River Mile
RMS	Root Mean Squared
RPM	Reasonable and Prudent Measure
SEL	Sound Exposure Level
SPL	Sound Pressure Level
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
U.S.C.	United States Code
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

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 U.S.C. 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 the Columbia Basin Branch, Ellensburg, Washington.

1.2. Consultation History

NMFS received a biological assessment (BA) from the U.S. Army Corps of Engineers (Corps) on July 26, 2021. The BA was prepared by Campbell Environmental LLC on behalf of the Oregon Parks and Recreation Department (OPRD). The Corps will permit OPRD under 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 Corps concluded that the proposed action is 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, 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.

NMFS initiated formal consultation on July 27, 2021.

1.3. Proposed Federal Action

Under the ESA, "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). Under ESA, 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 proposes to issue a permit to the OPRD for upgrades and improvements to the Mayer State Park Boat Launch and park facility located on Salisbury Slough on the Columbia River at RM 181.1, near Rowena, Oregon (Figure 1). The existing boat ramp and boarding dock require frequent maintenance for safety and use. The new ramp and boarding dock will reduce maintenance and improve public safety and accessibility for boat launching during low water levels. The proposed repairs and improvements will include removal, replacement and upgrading the boat ramp and boarding dock. It will also include upgrades to the parking lot and access including the addition of stormwater treatment facilities, and upgrading the restroom facility to meet compatibility with American with Disabilities Act. The proposed project will require up to 8 weeks of in-water construction work.

Figure 1: Project Location

Mayer State Park: Boat Launch Facility Improvements

(Google Earth 2021; USGS 2021)

Figure 1. Site Location: Mayer State Park Boat Launch Improvement Project.

1.3.1. Boat Ramp Replacement and In-water Construction

The proposed action will remove and replace the existing 30-foot by 92-foot asphalt and concrete segments of the boat ramp launch with a new 26.5-foot by 125-foot concrete boat ramp. The complete boat ramp will consist of a cast-in-place (26.5-foot by 37-foot) and a (26.5-foot by 88-

foot) precast concrete ramp. The proposed upgraded new boat launch will be approximately 3,313 square feet (ft^2), and extend an additional 35 ft into the waterbody. The new ramp size will result in an overall ramp size increase of 1,453 ft^2 , including an approximate increase of 265 ft^2 of additional concrete boat ramp below the ordinary high water mark (OHWM) in the Columbia River. The upgrades to the boat ramp will improve the safety and accessibility for public users launching recreational boats at a range of water levels.

Prior to any in-water construction, turbidity curtains will be deployed from the shoreline out into the Columbia River to create an in-water isolation work area (12,700 ft^2). The turbidity curtains will remain in contact with the channel substrate as the turbidity curtains are pushed out into deeper water. This method aims to create an in-water isolation work area and will herd fish out of the work area, as the curtains are placed to surround the entire in-water boat ramp and boarding dock construction site. This will minimize the presence of fish during in-water construction of the boat ramp and boarding dock and reduce potential interactions of fish with construction equipment. Precast concrete planks will be used to form the ramp below the water surface. Water levels vary at the end of the boat ramp between 6 ft deep at low water and up to 16 ft deep when the river is at the highest surface flow level. Cast-in-place concrete will be used to form the landward portion of the ramp, and will be constructed in the dry. Riprap will be installed along the edges of the boat ramp to protect the structure and reduce maintenance. Native substrates and river materials will be placed over the riprap to mimic a more natural stream substrate condition. Construction of the boat ramp will require excavation of up to 190 cubic yards (cu yd) and placement of up to 1,105 cu yd of riprap and fill within a 9,996 ft^2 area of shallow water near the Mayer State Park boat ramp. Appropriate isolation measures and best management practices (BMPs) will be implemented as described in the Conservation Measures section.

1.3.2. Boarding Dock Replacement

The existing 6-foot by 80-foot wood boarding dock will be replaced with a 6-foot by 140-foot boarding dock supported on four 12-inch-diameter steel pilings. The replacement boarding dock will be comprised of seven 20-foot dock sections constructed from aluminum shell with fully encapsulated floatation and fiberglass decking (Figure 2). The dock will be placed approximately 50 ft to the southwest of the replacement boat ramp and will result in an increase of 360 ft^2 of new overwater structure. The upgraded boarding dock will improve the access and ability of public users to safely board watercraft at the site.

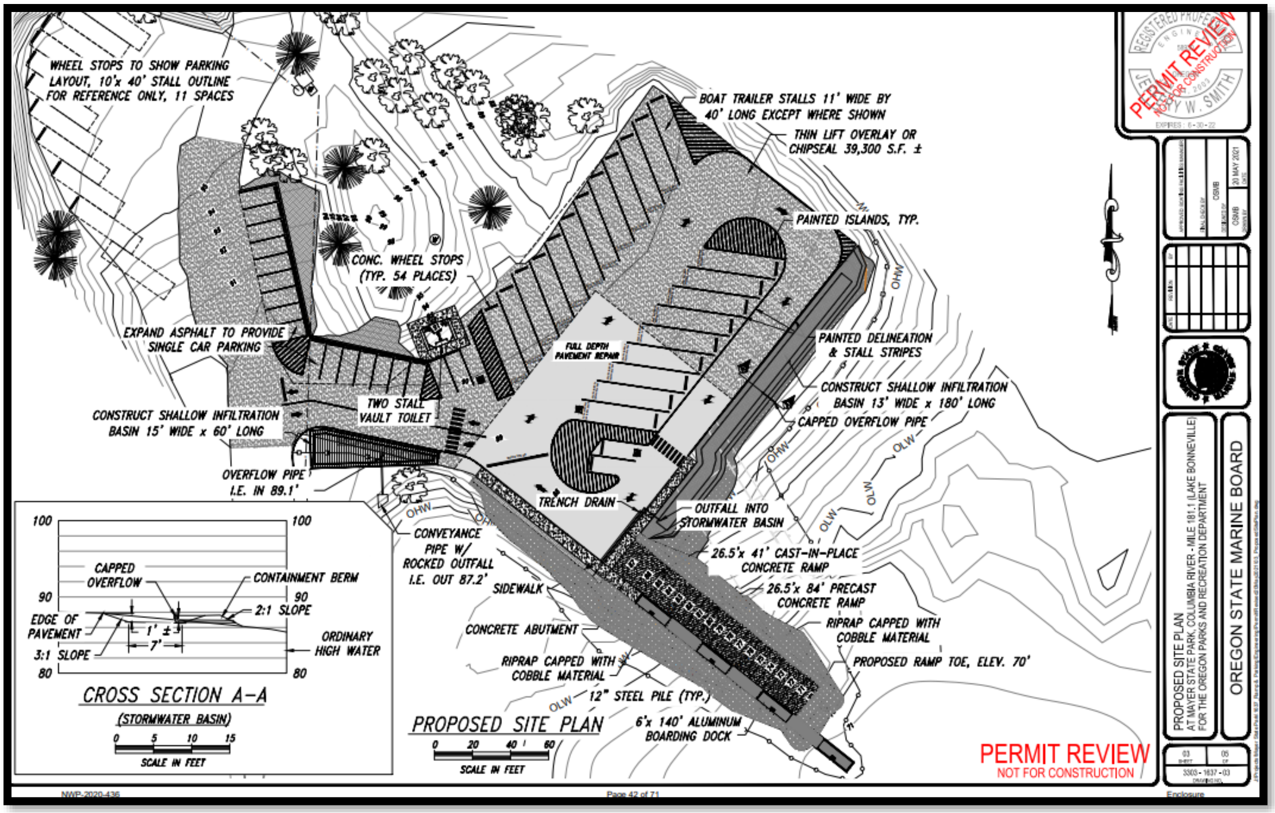

Figure 2. Proposed Mayer State Park Boat Ramp, Boarding Docking and Facilities Site Layout.

During the boat dock replacement, a shore operated vibratory driver will remove three existing steel piles then install four 12-inch-diameter steel support pilings. The pilings will be installed to a depth of approximately 30 ft into the substrate. Each piling will require approximately 15 to 30 minutes of vibratory driver use, with all four piles driven in a single day. We anticipate vibratory pile-driving would occur for up to 4 hours total. In the event that the vibratory driver cannot fully embed the piles to the required depth due to obstructions below the substrate, a few strikes from an impact driver may be required to seat the pilings. Based on details[1] provided from OPRD, it is anticipated that not more than 50 strikes would be needed to seat all four piles. The contractor will implement appropriate sound attenuation methods during impact driving (i.e., "soft start" procedures and use of a bubble curtain) as outlined in the conservation measures.

1.3.3. Upland Improvements to Parking lot, Restrooms and Stormwater Treatment

Improvements to the Mayer State Park (Park) facilities include paving and reconfiguration the layout of the parking lot, installing concrete curbs to provide a clear delineation between parking, travel lanes and maneuvering areas. Upgrades will improve disability access for public users. All stormwater draining from the parking area will be captured and treated in infiltration swales for 50% of the 2-year/24-hour storm event. No untreated stormwater from the parking area will flow to the Columbia River. Stormwater runoff on the boat launch will be channeled onto a rock base

[1] Email on September 16, 2021 from Darrell Monk (OPRD) to Rebecca Viray (NMFS) regarding all total pile-driving implementation methods and installation of turbidity curtains for the in-water isolation area.

to eliminate erosion prior to infiltration through a rock trench. These stormwater designs have been approved by Oregon Department of Environmental Quality (ODEQ) for Oregon State Marine Board for both upland and in-water structures to be appropriate for locations close to water bodies.

A new 2-stall vault restroom with a septic tank will be installed and replace the existing vault toilet. Work will be coordinated with the County Sanitary Department to ensure that the structure meets all environmental standards.

1.3.4. Removal of Timber Pilings from Shallow-water Habitat

The proposed action will include the removal of 22 timber pilings located a short distance from the boat ramp and dock, to restore natural channel and benthic habitat within Salisbury Slough. A temporary floating barge (60 foot-long by 40 foot wide) will be stationed in the river to support a crane and strap that will vertically remove each pile. Removal of the old piles will occur over 2 days. The temporary barge will be present in the Columbia River approximately 4 days, not to exceed a week during the in-water work window (IWWW). The removal of the piles will partially mitigate for the increase in-water and over-water structures near the boat dock, and improve and restore access to available shallow water habitat in the project area for ESA-listed fish.

1.3.5. Conservation Measures

The following conservation measures and BMPs are identified in the BA to minimize or avoid effects to ESA-listed species and their critical habitat:

- All work conducted below the OHWM of the Columbia River/Salisbury Slough will occur during the Oregon Department of Fish and Wildlife recommended IWWW November 15–March 15; a period when ESA-listed fish species are less likely to be present within the vicinity of the project area.
- Upland work shall be isolated using sediment fence or other measures to prevent any runoff during storm events.
- Heavy equipment (i.e., excavator) working from the shore will access the project site via existing parking areas, disturbed upland areas, and the shoreline. The crane will be stationed on the floating barge.
- Floating turbidity curtains will be installed around the boat ramp and dock in-water work area. Turbidity curtains will be deployed starting from the shoreline and moved out into the Columbia River. This will herd fish out of the immediate project site. The turbidity curtains will surround the boat ramp and boarding dock construction site to reduce fish presence within the in-water work area.
- Turbidity curtains will remain in contact with the channel bottom substrate during in-water construction.
- During vibratory piling removal, the following criteria will be implemented to minimize sediment disturbance and sediment suspension:

  - Keep all equipment (e.g., bucket, cable, vibratory driver) out of the water, grip piles above the waterline, and complete work during low water and low current conditions.
  - Dislodge piling with a vibratory driver, when possible; never intentionally break a pile.
  - “Wake” the piling by vibrating to break the friction bond between the piling and sediment.
  - Slowly lift the pile from the sediment and through the water column.
  - Place the pile in a containment basin on a barge deck, pier, or shoreline without attempting to clean or remove any adhering sediment.
  - Dispose of all removed piles, floating surface debris, any sediment spilled on work surfaces, and all containment supplies at a permitted upland disposal site.
- When a pile breaks or is intractable during removal, removal will continue as follows:
  - Every attempt short of excavation will be made to remove each piling, if a pile in uncontaminated sediment is intractable, breaks above the surface, or breaks below the surface, cut the pile or stump off at least 3 ft below the surface of the sediment.
- All new pilings will be installed with a vibratory driver. In the event that substrates are too hard for the vibratory driver to install the piles to the necessary depth, the contractor will use an impact driver to seat the piles. Impact driver use will only occur for a single day.
- During the use of an impact driver, a multi-level bubble curtain will be installed to reduce sound pressure levels (SPLs).
  - The bubble curtain system shall conform to the following:
  - If water velocity is greater than 1.6 feet per second (fps), surround the piling being driven by a confined bubble curtain (e.g., a bubble ring surrounded by a fabric or non-metallic sleeve) that will distribute air bubbles around 100% of the piling perimeter for the full depth of the water column.
  - Piling shall be completely engulfed in bubbles over the full depth of the water column at all times when an impact pile driver is in use. Bubbles are not required during vibratory pile-driving.
  - Bubblers shall completely surround the pile.
- The contractor will initiate daily “soft start” procedures to provide a warning and/or give species near piling removal and installation activities a chance to leave the area prior to a vibratory driver or impact driver operating at full capacity; thereby, exposing fewer fish to loud underwater sounds.
  - A soft start procedure will be used at the beginning of in-water piling removal and installation, or any time piling removal/installation has ceased for more than 30 minutes.
  - For vibratory driver operation, the contractor will initiate noise from vibratory drivers for 15 seconds at reduced energy followed by a 30-second waiting period. The procedure shall be repeated two additional times.
  - For impact pile-driving (if necessary), the contractor will provide an initial set of strikes from the impact driver at reduced energy, followed by a 30-second waiting period, then two subsequent sets. (The reduced energy of an individual driver cannot be quantified given the variations between individual drivers. In addition,

the number of strikes will vary at reduced energy given that raising the driver at less than full power and then releasing it results in the driver bouncing as it strikes the pile, resulting in multiple strikes).

- A Pollution Control Plan (PCP) will be prepared by the contractor and carried out commensurate with the scope of the project that includes the following:
    - Best management practices to confine, remove, and dispose of construction waste.
    - Procedures to contain and control a spill of any hazardous material.
- All conditions of Oregon Department of Environmental Quality (ODEQ's) 401 Water Quality Certification will be followed.
- All equipment will be inspected daily for fluid leaks. Any leaks detected will be repaired before operation is resumed.
- Stationary power equipment (i.e., excavator) operated within 150 ft of the Columbia River will be diapered to prevent leaks.
- Precast concrete planks will be used below the water surface during construction. Cast in-place concrete will only be used in the dry. In no circumstances will uncured concrete be allowed to come in contact with waterways of the State.
- Bird deterrent devices (e.g., conical caps) will be installed on new pilings to prevent perching by piscivorous birds.
- All areas of temporary shoreline disturbance will be restored and re-vegetated with native seeding and/or plantings.

We considered whether or not the proposed action would cause any other activities. The boat ramp and boarding dock replacement will improve safety and ease for public access. The upgrades will accommodate disability access at the boarding dock. In addition, as the ramp replacement will allow boats to launch at a wider range of water surface levels. We have determined the proposed action may result in a small increase in boat use above the existing baseline use at the site. We describe these potential effects in Section 2.5, Effects of the Action.

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 reasonable and prudent measures (RPMs) and terms and conditions to minimize such impacts.

2.1. Analytical Approach

This biological 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 CFR 402.02). Therefore, the jeopardy analysis considers both survival and recovery of the species.

This biological 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 for some of the above species 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 biological 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

This opinion examines 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 PBFs that are essential for the conservation of the species.

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 salmon, steelhead, 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 (https://www.westcoast.fisheries.noaa.gov). The next 5-year status reviews will be completed in 2022.

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 evolutionarily significant unit (ESU) was listed as endangered under the ESA in 1999 (64 FR 14308), and the status was affirmed in 2005 and 2012. In 2016, the 5-year status review for UCR spring-run Chinook salmon concluded that the species should maintain its endangered listing classification (NMFS 2016c; NWFSC 2015).

A recovery plan is available for this species (UCSRB 2007). A 5-year status review was completed in 2016 (NMFS 2016c). 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 Upper Columbia Salmon Recovery Board (UCSRB) Plan. The recovery plan calls for meeting or exceeding the same basic spatial structure and diversity (SS/D) criteria adopted from the Interior Columbia Technical Recovery Team (ICTRT) viability report for recovery (NWFSC 2015). None of the three extant populations in this ESU are viable with respect to abundance and productivity (A&P), and they all have a greater than 25% chance of extinction in 100 years (UCSRB 2007).

Spatial structure and diversity. This species includes all naturally-spawned populations of spring-run 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 (MPGs). Two of these MPGs were eliminated by the completion of Grand Coulee and Chief Joseph Dams (UCSRB 2007; NWFSC 2015). The remaining North Cascades MPG is comprised of three extant populations: the Wenatchee River, the Methow River, and the Entiat River populations.

The composite SS/D risks for all three of the extant populations in this MPG are rated at high risk. 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 populations are rated at high risk for diversity, driven primarily by chronically high proportions of hatchery-origin spawners (26–76%) 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% and 76%, respectively (NMFS 2015). 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. NMFS (2020) discussed updated adult abundance estimates for UCR spring-run Chinook salmon. These indicate a substantial downward trend in natural-origin spawners at the ESU level from 2015 to 2019. Returns through 2018, for each of the three extant populations, remained considerably below the minimum abundance thresholds established by the ICTRT with substantial numbers of hatchery-origin fish on the spawning grounds.

Estimated productivity (returns-per-spawner) was on average about the same in 2009 to 2018 as in 1999 to 2008, and indicates that UCR spring-run Chinook salmon populations are not replacing themselves. Possible contributing factors include density dependent effects, differences in spawning distribution relative to habitat quality, and reduced fitness of hatchery-origin spawners. As of the last status review, the combinations of recent A&P for each population had resulted in a high-risk rating for the ESU when compared to the ICTRT viability curves (NWFSC 2015).

There have been improvements in the viability ratings for some of the component populations, but overall several of the factors cited by the ICTRT (2007) remain as concerns or key uncertainties. Since 2016, observations of coastal ocean conditions indicate that recent outmigrant year classes have experienced below average ocean survival during a marine heatwave and its lingering effects, which led researchers to predict the drop in adult returns observed through 2019 (Werner et al. 2017). Expectations for marine survival are relatively mixed for juvenile Chinook salmon that reached the ocean in 2019 (Zabel et al. 2020). NMFS will evaluate the implications for viability risk of more recent adult returns in the upcoming 5-year status review, expected in 2021. The status review will also consider new information on population productivity, diversity, and spatial structure.

Limiting factors. Limiting factors include (NOAA 2011; UCSRB 2007):

- 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.
- 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.
- Harvest in Columbia River fisheries.

Snake River Spring/Summer-run Chinook Salmon ESU

NMFS listed the SR spring/summer-run Chinook salmon ESU as a threatened species in 1992. The status was affirmed in 2005 and in 2014. NMFS released a final recovery plan for this species in October of 2017 (NMFS 2017a), and the most recent status review was completed in 2016 (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 (DOC 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 (ICTRT 2003; McClure and Cooney 2005). All but one extant population (Chamberlain Creek) are at "high" risk of extinction (Ford 2011; 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.

Abundance and productivity. NMFS (2020) discussed updated adult abundance estimates for SR spring/summer Chinook salmon. These indicated a substantial downward trend in natural-origin spawners at the ESU level from 2014 to 2019. Returns during the last 3 years in the series, 2017 through 2019, were the lowest since 1999. These data also showed recent and substantial downward trends for most of the MPGs and populations, except those in the Lemhi River, Camas Creek, and Upper Grande Ronde Mainstem, when compared to the 2009 to 2013 period. All populations except Chamberlain Creek remained considerably below the minimum abundance thresholds established by the ICTRT. For many populations, the total spawner counts include substantial numbers of hatchery-origin adults. Exceptions were the entirety of the Middle Fork MPG and several populations in the Upper Salmon MPG. NMFS will evaluate the implications for viability risk of these more recent returns in the upcoming 5-year status review, expected in 2021. The status review will also consider new information on population productivity, diversity, and spatial structure.

Most populations will need to see increases in A&P in order for the ESU to recover. As of the last status review, NWFSC (2015) stated that the SR spring/summer-run Chinook salmon ESU remained at high overall risk.

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.
- Poor ocean survival.

Snake River Fall-run Chinook Salmon ESU

Snake River fall-run Chinook salmon were originally listed as threatened in 1992 (57 FR 14653). The status was affirmed in 2005 and in 2014. NMFS released a final recovery plan for this species in November 2017 (NMFS 2017b). A 5-year status review was completed in 2016 (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 (DOC 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 and Cooney 2005). The extant population has a high proportion of hatchery-origin spawners.

NMFS (2020) discussed updated adult abundance estimates for SR fall Chinook salmon. These indicated a substantial downward trend in the abundance of natural-origin spawners at the ESU level during 2013 to 2019. However, overall abundance remained higher than before 2005. NMFS will evaluate the implications for viability risk of these more recent returns in the upcoming 5-year status review, expected in 2021. The status review will also consider new information on productivity, diversity, and spatial structure.

The SR fall Chinook salmon ESU is composed of a single demographically independent population. Five-year geometric means in the numbers of natural-origin and total (natural- plus hatchery-origin) spawners through 2018 indicated very small negative changes in abundance between the two most recent 5-year periods (NMFS 2020).

As of the last status review, the ESU was considered viable, but would need to see an increase in productivity combined with a reduction in diversity risk to recover (ICTRT 2010; NWFSC 2015). The single population delisting options provided in the draft Snake River Fall Chinook Recovery Plan would require the population to meet or exceed minimum requirements for Highly Viable with a high degree of certainty (NWFSC 2015).

Limiting factors. Limiting factors for this species include:

- Degradation of floodplain connectivity, 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. NMFS released a final recovery plan for this species on June 8, 2015 (NMFS 2015). The most recent 5-year status review was completed in 2016 (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 SRB, Idaho, and artificially-propagated sockeye salmon from the Redfish Lake Captive Broodstock Programs (DOC 2014). 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). At this stage of the recovery efforts with limited distribution across the Sawtooth Valley lakes, the ESU remains rated at high risk for both spatial structure and diversity (NWFSC 2015).

Abundance and productivity. NMFS (2020) discussed updated adult abundance estimates for SR sockeye salmon. These indicate a substantial downward trend in the returns of hatchery-origin and natural-origin adults to the Sawtooth Valley since 2014. The 5-year geometric mean of total spawner counts declined 6% in 2014 to 2018 when compared to 2009 to 2013. NMFS will evaluate the implications for viability risk of these more recent returns in the upcoming 5-year status review, expected in 2021. The status review will also consider new information on productivity, diversity, and spatial structure.

Limiting factors. The key factor limiting recovery of the SR sockeye salmon ESU is survival. In the Sawtooth Valley natal lakes, limiting factors include blocked access; low zooplankton density (which can restrict sockeye salmon growth and fitness); current and legacy effects of land use and other human activities such as mining, grazing, recreational use, lakeshore development, and irrigation diversions; lake poisoning; and introduction and continued stocking of non-native species (such as brook trout, rainbow trout, lake trout, and kokanee).

Portions of the migration corridor in the Salmon River are impaired by reduced water quality and elevated temperatures (IDEQ 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%, range of 0–67% for 1991–1999) (Keefer et al. 2008b). Keefer et al. (2008b) 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. (2008b) 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% of all salmon smolts reaching the estuary, and piscivorous fish consume an estimated 8% of migrating juvenile salmon (NOAA 2011), a significant source of mortality.

Climate change is a substantial threat to SR sockeye salmon, especially during the marine rearing phase and adult migration phase of their life cycle. High temperatures in 2013 and 2015 resulted in unusually high mortality rates in both the lower Columbia (Bonneville to McNary Dam) and lower Snake River (McNary to Lower Granite Dam) reaches, as well as in the reach from Lower Granite Dam to the Sawtooth Basin. Excluding 2015, recent adult survival rate estimates for SR sockeye salmon have averaged about 77% from Bonneville to McNary Dam (2010 to 2019), about 89% from McNary to Lower Granite Dams (2010 to 2017) and 65% from Bonneville to Lower Granite Dams (2010 to 2017). In 2015, due to unprecedented early high water temperatures that persisted throughout the summer in the Columbia River basin, only 15% of adult SR sockeye salmon survived from Bonneville to McNary Dam and only 4% survived from Bonneville to Lower Granite Dam (NMFS 2020). It is uncertain how frequently similar conditions might occur in the future, though it will certainly be more often than in the past.

The quality of data used to evaluate climate-related threats is limited, and our understanding of how salmonids, and the ecosystems upon which they depend, might respond is even more limited. However, climate change would likely affect SR sockeye salmon in the following ways:

- Changes in ocean survival
- Changes in growth and development rates
- Changes in disease resistance

- Changes in flow regime (especially flooding and low-flow events) that could affect survival and behavior (run timing, spawning timing, etc.)

Recent analyses by Crozier et al. (2019) rated the vulnerability of SR sockeye salmon as very high. We generally expect that abundance could decrease and extinction risk increase as a result of climate change.

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 (NMFS 2016c).

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 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. NMFS (2020) discussed updated adult abundance estimates for UCR steelhead. These indicate a substantial downward trend in the number of natural-origin spawners at the DPS level from 2014 to 2019. Population level estimates of natural-origin and total (natural- and hatchery-origin) spawners through 2018 also showed recent and substantial downward trends for most of the populations. All populations remain considerably below the minimum abundance thresholds established by the ICTRT.

NMFS will evaluate the implications for viability risk of these more recent returns in the upcoming 5-year status review, expected in 2021. The status review will also consider new information on productivity, diversity, and spatial structure.

Limiting Factors. Limiting factors for this species include (NOAA 2011; 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 threatened under the ESA in 1991 (62 FR 43937). In October of 2017, NMFS released the final SR Spring/Summer-run Chinook Salmon and Steelhead Recovery Plan (NMFS 2017a). The most recent 5-year status review was completed in 2016 (NMFS 2016b). The overall viability ratings for natural populations in the SRB steelhead DPS range from moderate to high risk. Four out of the six 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 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 technical review that would change those ratings (NMFS 2016).

Abundance and productivity. NMFS (2020) discussed updated adult abundance estimates for SRB steelhead. These indicate a substantial downward trend in the abundance of natural-origin spawners at the DPS level from 2014 to 2019. The number of natural-origin spawners in the Upper Grande Ronde Mainstem population appears to have been at or above the minimum abundance threshold established by the ICTRT, while the Tucannon River and Asotin Creek populations have remained below their respective thresholds. The 2019 abundance level for the Tucannon River population was lower than the most recent 5-year geomean. For many other SRB steelhead populations, spawning ground surveys are not feasible due to high spring flows that would wash out weirs and low visibility that precludes redd counts. The Idaho Department of Fish and Game, Columbia River Inter-Tribal Fish Commission, and the Northwest Fisheries Science Center (NWFSC) therefore collect tissue samples from adult steelhead trapped at Lower Granite Dam and assign these fish to genetic stocks by comparing them to samples taken inside the boundary of each spawning population (NMFS 2020). The genetic stock identification groups are broader than spawning populations, but fit within the MPGs. The most recent 5-year geometric means indicate large decreases in natural-origin abundance for most of the genetic stocks/MPGs, with a smaller decrease for the Upper Clearwater genetic stock group.

NMFS will evaluate the implications for viability risk of these more recent returns in the upcoming 5-year status review, expected in 2021. The status review will also consider new information on population productivity, diversity, and spatial structure.

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

- 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 as a threatened species (64 FR 14517). A recovery plan is available for this species (NMFS 2009). The most recent 5-year status review was completed in 2016 (NMFS 2016a).

Spatial structure and diversity. 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 SRB. This DPS includes steelhead from seven artificial propagation programs (DOC 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 (DOC 2014). The ICTRT identified 17 extant populations in this DPS (ICTRT 2003; McClure and Cooney 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 and Cooney 2005). Viability ratings for these populations range from extirpated to viable (NMFS 2009, NWFSC 2015).

Abundance and productivity. NMFS (2020) discussed updated adult abundance estimates for MCR steelhead. These indicate a substantial downward trend in the abundance of natural-origin spawners at the DPS level from 2014 to 2019. Population level estimates of natural-origin and total (natural- plus hatchery-origin) spawners through 2018 or 2019 also showed recent and substantial downward trends in abundance for most of the MPGs and populations (exceptions are the Klickitat and Yakima River populations) when compared to the 2009 to 2013 period. In many cases, the most recent 5-year geometric mean in natural-origin abundance is considerably below the minimum abundance thresholds established by the ICTRT. However, the Klickitat, Middle Fork John Day, and Umatilla River populations are well above these thresholds. A relatively limited number of hatchery fish is present on the spawning grounds within this DPS.

NMFS will evaluate the implications for viability risk of these more recent returns in the upcoming 5-year status review, expected in 2021. The status review will also consider new information on productivity, diversity, and spatial structure.

Limiting factors. Limiting factors for this species include (NMFS 2009; NOAA Fisheries 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 by examining the condition and trends of the essential PBFs of that habitat throughout the designated areas (Tables 2 and 3). 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 2. 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 spawning	Substrate Water quality Water quantity	Adult spawning Embryo incubation Alevin growth and development
Freshwater rearing	Floodplain connectivity Forage Natural cover Water quality Water quantity	Fry emergence from gravel Fry/parr/smolt growth and development
Freshwater migration	Free of artificial obstruction Natural cover Water quality Water quantity	Adult sexual maturation Adult upstream migration and holding Kelt (steelhead) seaward migration Fry/parr/smolt growth, development, and seaward migration
Estuarine areas	Forage Free of artificial obstruction Natural cover Salinity Water quality Water quantity	Adult sexual maturation and "reverse smoltification" Adult upstream migration and holding Kelt (steelhead) seaward migration Fry/parr/smolt growth, development, and seaward migration

Physical or Biological Features		Species Life History Event
Site Type	**Site Attribute**	
Nearshore marine areas	Forage Free of artificial obstruction Natural cover Water quantity Water quality	Adult growth and sexual maturation Adult spawning migration Nearshore juvenile rearing

Table 3. 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 temperature (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 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.

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 developments. 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 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 adults 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, 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 2011a).

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 CHARTs 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 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 4.

Table 4. Critical habitat, designation date, Federal Register (FR) 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 fifth-field hydrologic unit code (HUC5) watersheds with physical or biological features (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 the conservation value of HUC5 watersheds as high for 10 watersheds, and medium for five watersheds. The conservation value of migration habitat in this area has been affected by the development and operation of the dams and reservoirs of the Columbia River Systems.

Species	Designation Date and Federal Register Citation	Critical Habitat Status Summary
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 evolutionarily significant unit (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 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 primary constituent elements (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 the conservation value of HUC5 watersheds as high for 20 watersheds, medium for eight watersheds, and low for three watersheds.

Species	Designation Date and Federal Register Citation	Critical Habitat Status Summary
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 the 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.

2.2.3 Climate Change

One factor affecting the range-wide status of salmon and steelhead and aquatic habitat is climate change. The U.S. Global Change Research Program (2018) reports average warming in the Pacific Northwest of about 1.3 degrees Fahrenheit (ºF) from 1895 to 2011, and projects an increase in average annual temperature of 3.3ºF to 9.7ºF by 2070 to 2099 (compared to the period 1970 to 1999), depending largely on total global emissions of heat-trapping gases; the increases are projected to be largest in summer (Melillo et al. 2014; USGCRB 2018). The five warmest years in the 1880 to 2019 record have all occurred since 2015, while 9 of the 10 warmest years have occurred since 2005 (Lindsey and Dahlman 2020). Climate change has negative implications for designated critical habitats in the Pacific Northwest (Mantua et al. 2009; ISAB 2007; Scheuerell and Williams 2005; Zabel et al. 2006), characterized by the Independent Scientific Advisory Board (ISAB) as follows:

- Warmer air temperatures will result in diminished snowpack and a shift to more winter/spring rain and runoff, rather than snow that is stored until the spring/summer melt season.

- With a smaller snowpack, watershed runoff will decrease earlier in the season, resulting in lower stream flows in June through September. Peak river flows, and river flows in general, are likely to increase during the winter due to more precipitation falling as rain rather than snow.

- Water temperatures are expected to rise, especially during the summer months when lower stream flows co-occur with warmer air temperatures.

These changes will not be spatially homogeneous across the entire Pacific Northwest. Low-lying areas are likely to be more affected. Climate change may have long-term effects that include, but are not limited to, depletion of important cold-water habitat, variation in quality and quantity of tributary rearing habitat, alterations to migration patterns, accelerated embryo development, earlier emergence of fry, and increased competition among species (Goode et al. 2013; Reeder et al. 2013).

Climate change is predicted to cause a variety of impacts to Pacific salmon and their ecosystems (Crozier et al. 2008; Martins et al. 2012; Mote et al. 2014; Mote et al. 2016; Wainwright and Weitkamp 2013). The complex life cycles of anadromous fishes, including salmon, rely on productive freshwater, estuarine, and marine habitats for growth and survival, making them particularly vulnerable to environmental variation. Ultimately, the effects of climate change on salmon and steelhead across the Pacific Northwest will be determined by the specific nature, level, and rate of change and the synergy among interconnected terrestrial/freshwater, estuarine, nearshore, and ocean environments.

The primary effects of climate change on Pacific Northwest salmon and steelhead are:

- Direct effects of increased water temperatures on fish physiology.
- Temperature-induced changes to stream flow patterns, which can block fish migration, trap fish in dewatered sections, dewater redds, introduce non-native fish, and degrade water quality.
- Alterations to freshwater, estuarine, and marine food webs that alter the availability and timing of food resources.
- Changes in estuarine and ocean productivity that affect the abundance and productivity of fish resources.

Climate change is expected to make recovery targets for salmon and steelhead populations more difficult to achieve. Climate change is expected to alter critical habitat by generally increasing temperature and peak flows and decreasing base flows (Mantua et al. 2010). Although changes will not be spatially homogenous, effects of climate change are expected to decrease the capacity of critical habitat to support successful spawning, rearing, and migration. Habitat action can address the adverse impacts of climate change on salmon. Examples include restoring connections to historical floodplains and freshwater and estuarine habitats to provide fish refugia and areas to store excess floodwaters, protecting and restoring riparian vegetation to ameliorate stream temperature increases, and purchasing or applying easements to lands that provide important cold water or refuge habitat (Battin et al. 2007; ISAB 2007).

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 for the proposed action includes the area surrounding the in-water activity at the Mayer State Park River

Mile (RM) 181.1 of the Columbia River. The action area extends in a radius up to 2,815 ft. (858 m) from the existing boat ramp. The extent of the action area is based on the anticipated behavioral effects from underwater SPLs generated during impact pile driving. The action area includes the in-water project site, riparian, and upland areas and areas upstream and downstream of the in-water work area that are likely to be affected by the proposed action.

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).

Current conditions within much of the mainstem Columbia River are degraded relative to historical conditions, a reflection of a multitude of actions whose effects frame the environmental baseline in the action area. The hydropower system has greatly modified natural flow and altered the hydrograph of the Columbia River. Water impoundments have altered water quality resulting in higher water temperatures during some parts of the year and elevated background turbidity (Gilbreath et al. 2000), changed fish community structure leading to increased rates of piscivorous, predation on juvenile salmon and steelhead, and altered fish passage and delayed migration for both adults and juveniles. Shoreline development has reduced natural vegetation, disconnected floodplains, and reduced available off-channel refugia.

The mainstem dams and reservoirs, such as Bonneville Reservoir, 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). Harnish et al. (2014) documented significant mortality of smolts and juvenile Chinook salmon in reservoirs from the large populations of piscivorous fish and bird colonies.

In addition, numerous anthropogenic features or activities near the project site and throughout 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 historical 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.

On the mainstem Columbia River, hydropower projects, water storage projects and the withdrawal of water for irrigation and urban uses have significantly degraded salmon and steelhead habitats (NMFS 2013). The volume of water discharged by the Columbia River varies seasonally according to runoff, snowmelt, and hydrosystem demands. Mean annual discharge is estimated to be 265 thousands of cubic feet per second (kcfs), but may range from lows of 71 to 106 kcfs to highs of 539 kcfs. Water management activities have reduced flows in the Columbia River, measured at Bonneville Dam, from April through July. Flow management for hydropower has increased flows measured at Bonneville Dam during winter months. Naturally occurring maximum flows on the Columbia River occur in May, June, and July as a result of snowmelt in headwater regions. Minimum flows occur from September to March, with periodic peaks due to winter rains. Interannual variability in stream flow is strongly correlated with two recurrent climate phenomena, the El Nino/Southern Oscillation and the Pacific Decadal Oscillation.

Bonneville Dam has created reservoir conditions in the project vicinity, with daily fluctuations in water level. Bonneville Reservoir is considered water quality limited by the ODEQ and it is on the Clean Water Act section 303(d) list for water temperature and pH (ODEQ 2020). 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 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. The Columbia River within the action area likely serves as juvenile rearing habitat and as an adult and juvenile migration corridor for all ESUs/DPSs. Project activities will occur during winter, the recommended in-water work period, when adults do not typically occupy the project area.

Specifically, the project site is located along the eastern end of the Columbia River Gorge in Oregon. The site is within the Bonneville Dam Reservoir on the southern shoreline of the Columbia River, 35 miles east of the Bonneville Dam. The location is at an existing day-use Oregon State Park facility that includes a boat ramp, small boarding dock, public parking lot and access road for vehicles and boats, a vault restroom, and day use facilities. Public use includes picnicking, fishing, swimming and boat access. The existing boat ramp is deteriorated and exposes rebar and debris that can damage boats at low river flow. The topography of the uplands is relatively open and flat. The Union Pacific Railroad line passes through the Park. The area around Mayer State Park has been anthropogenically altered with riprap along the boat ramp and shoreline, and the upland park areas are maintained grass areas with ponderosa pines and sparse understory native and non-native vegetation. The shoreline is composed of riprap, coarse sand, cobble size rock and depositional materials with scattered shrubs along the riverbanks. Large wood and complex channel habitat features are lacking in the immediate project area. No other site-specific monitoring data or fish surveys were available from the project site.

Adult Chinook salmon are not expected to be in near shore waters of the project in-water construction. An occasional adult UCR, MCR and SRB steelhead could be present year round in the mainstem Columbia River. Daily counts at the Bonneville Dam have found few individual adult steelhead migrate during the winter months, with small increases in numbers of individual adults passing the dams in late February and March (Columbia River DART 2021).

Older juvenile salmon and steelhead (+1 age class) use a variety of habitats including nearshore, off-channel, mid-channel, and deep-water habitats. Subyearling Chinook salmon generally remain close to the water surface, favoring habitat less than 6 ft deep and where currents do not exceed 0.1 fps. 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. Dauble et al. (1989) found that spring-run Chinook salmon smolts were often abundant just after sunset in shallow nearshore areas (less than 30 cm deep) of low current velocity. 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 ft. and Chinook salmon migrating at a mean depth of 10 ft. A study by Timko et al. (2011) recorded juvenile steelhead migrating in the top 5 to 15 ft. of the water column in the Priest Rapids Project (which is located upstream of the project area). 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. Thus, we expect spring-run juvenile Chinook salmon and steelhead to be present at the project site during the in-water construction.

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).

The action will include effects caused by: in-water excavation and placement of fill and riprap below the OHWM; installation of turbidity curtains for the temporary in-water work area; vibratory and impact pile driving; and installation and use of the boat ramp and boarding dock. Effects to listed species and critical habitat in the action area will likely occur as a consequence of construction of the boat ramp and boarding dock along the banks and shallow water of the Columbia River.

2.5.1. Fish Presence in the Action Area

Fish presence in the action area consists of different-sized species and age classes of salmon and steelhead that rear and migrate throughout the Columbia River. 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 salmon of all ESUs and DPSs in this opinion may migrate and overwinter in the Bonneville Reservoir (Table 5). A few adult steelhead of each DPS could be present year-round in the mainstem Columbia River (Keefer et al. 2008a). However, based on habitat quality and the number of adults in the Bonneville Reservoir, we anticipate that the number of adult steelhead of any DPS to be holding or migrating in the action area during the in-water construction work window (November 15 to March 15) will be small (a few fish). Adult sockeye salmon are not typically present during the winter months when in-water construction will occur. We anticipate a few individual adult Chinook salmon may migrate through the Bonneville Reservoir starting in mid-March towards the end of the IWWW.

Adult Chinook salmon are not expected to be in nearshore waters in the vicinity of the project during in-water construction. An occasional adult UCR, MCR and SRB steelhead could be present year round in the mainstem Columbia River. Daily counts at the Bonneville Dam have found few individual adult steelhead migrate during the winter months, with small increases in numbers of individual adults passing the dams in late February and March (Columbia River DART 2021).

Older juvenile salmon and steelhead (+1 age class) use a variety of habitats including nearshore, off-channel, mid-channel, and deep-water habitats. Subyearling Chinook salmon generally remain close to the water surface, favoring habitat less than 6 ft. deep and where currents do not exceed 0.1 fps. 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. Dauble et al. (1989) found that spring-run Chinook salmon smolts were often abundant just after sunset in shallow nearshore areas (less than 30 cm deep) of low current velocity. 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 ft and Chinook salmon migrating at a mean depth of 10 ft. A study by Timko et al. (2011) recorded juvenile steelhead migrating in the top 5 to 15 ft. of the water column in the Priest Rapids Project (which is located upstream of the project area). 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. Thus, we expect spring-run juvenile Chinook salmon and steelhead to be present at the project site during the in-water construction.

Table 5. Timing of fish presence in the action area.

Species	Life Stage	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
		*IWWW											*IWWW
UCR Steelhead	Adult	MIGRATION											
	Juvenile	MIGRATION and REARING											
MCR Steelhead	Adult	MIGRATION											
	Juvenile	MIGRATION and REARING											
SRB Steelhead	Adult	MIGRATION											
	Juvenile	MIGRATION and REARING											
UCR Spring-run Chinook salmon	Adult			MIGRATION (mid-March to mid-June)									
	Juvenile	MIGRATION and REARING											
SR fall-run Chinook salmon	Adult								MIGRATION				
	Juvenile	MIGRATION and REARING											
SR Spring-Summer Chinook salmon	Adult			MIGRATION (mid-March to late October)									
	Juvenile	MIGRATION and REARING											
Sockeye Salmon	Adult					MIGRATION (mid-May to mid-November)							
	Juvenile	MIGRATION and REARING											

*Oregon Department of Fish and Wildlife recommended in-water work window (IWWW) from November 15 to March 15 (ODFW 2008).

2.5.2. Effects to Species

We anticipate short-term effects to exposed species and life stages during in-water construction, pile-driving, and the installation of the new boat ramp and boarding dock. The effects include: the potential of behavioral modification, as well as harm, injury and death during in-water construction; reduced water quality during construction; injury and death from pile-driving; and temporary altered fish passage and migration due to the in-water isolation area. We anticipate short and long-term effects as a consequence of potential increased predation risk from increased in-water and over-water structures. We also expect long–term beneficial effects from removal of 22 piles that should reduce predation. These effects are described below.

Harm or Mechanical Injury from In-water Construction
The proposed action includes in-water construction using heavy equipment and vibratory driving to remove and replace the boat launch and boarding dock. In-water construction work will occur in waters up to 16 ft. deep and disturb an area of 9,996 ft^2 at the Mayer State Park. Turbidity curtains will be installed, starting from the shoreline, and deployed out to deeper waters to surround the overall in-water isolation work area (12,700 ft^2). The seines will herd fish out beyond the immediate work area, and we anticipate most fish will flee, swimming into deeper waters, or other available habitat in the action area. The work isolation area will reduce fish presence in the immediate work area during construction. However, during the installation of the turbidity curtain, some fish will likely experience behavioral modifications as they remain within

the work area, moving either into the substrate or not successfully being herded out. A small number of juvenile fish are expected to remain within the work area inside the turbidity curtain. Of these fish, it is likely that some individual fish will flee or avoid the in-water construction. Adults and older juveniles are generally better at avoiding this kind of disturbance. Some fish are less likely to successfully flee, and they may confined within the work area and be injured or killed. In-water activities will take up to 8 weeks, and will occur between November 15 and March 15. Based on this timing and the shallow site characteristics, only subyearling Chinook and juvenile steelhead from any of the ESUs/DPSs are expected to be present. We do not expect any adult fish to be present within the turbidity curtain.

Any juvenile fish present within the turbidity curtain isolation area during the in-water work will likely be injured or killed. To determine the amount of injury or death to juvenile salmon or steelhead that will occur during in-water construction, NMFS used the fish densities of 0.0023 subyearling Chinook salmon per square foot, and fish densities of 0.0012 juvenile steelhead per square foot found in poor quality habitat (Mullan et al. 1992), and the maximum work isolation area (12,700 ft^2). Few surveys and data are available of juvenile salmonids densities within the shallow water habitats within in the Bonneville Reservoirs. We considered the fish densities found by (Mullan et al. 1992) and the size of the in-water isolation area to calculate the anticipated number of listed salmon and steelhead in the work area. We considered the studies in Mullan et al. 1992, while dated, as still appropriate due to its relevance to salmon productivity within the Middle Columbia Basin geography. Our calculation estimated a maximum of 29 juveniles or subyearling Chinook salmon (including UCR spring-run, SR spring/summer-run, SR fall-run Chinook salmon), and an estimated maximum of 15 juveniles steelhead (including MCR steelhead, UCR steelhead and SRB steelhead) are likely to be present within the isolation area. We anticipate the installation of the turbidity curtains and in-water isolation area may further reduce the number of fish present in the work area. Any fish injured or killed will likely be distributed among any of the populations that could be present. However, for the purposes of this analysis, we assume 29 juvenile Chinook salmon and 15 juvenile steelhead will be injured or killed by in-water construction activities.

Water Quality

Sedimentation and turbidity. The proposed project includes in-water construction below the OHWM involving excavation to remove existing in-water and over-water structures, and placement of fill, riprap, and installation of piles, boat ramp and the boarding dock. Heavy machinery and equipment will remove structures and disturb the channel substrate during in-water work. Suspended sediment and turbidity will increase within the in-water work area.

Effects to salmonids are reasonably likely to occur from substrate disturbance though in-water excavation and construction activities. These activities will temporarily increase delivery of fine sediments, increase turbidity in the water column, and degrade water quality.

All in-water construction is anticipated to occur for up to 8 weeks. The proposed action will increase turbidity each day excavation or in-water construction occurs. Because the contractor will install floating turbidity curtains around the in-water construction area, we expect most of the sediment and turbidity generated will remain within the in-water work area. Turbidity levels will be high within the isolation area each day (approximately 12,700 ft^2) and will likely settle out overnight, but rise again in the morning when in-water work resumes. Any fish remaining inside of the turbidity curtain will experience the full effects of increased turbidity levels and may be killed or injured. However, these fish are the same fish that will experience potential injury from construction equipment related effects (29 juvenile Chinook salmon and 15 juvenile steelhead). Outside of the in-water isolation area, we expect the turbidity levels to be near or slightly above background (see below for discussion of background levels in the reservoir in winter). The installation and removal of the turbidity or sediment curtains will increase turbidity and suspended sediment concentrations surrounding the in-water work area. We expect turbidity levels following the in-water work curtain removal to not exceed 50 nephelometric turbidity units (NTU), or 10% above background levels outside of the in-water construction area. This suspended sediment plume is expected to dissipate quickly and only last minutes.

The effects of suspended sediment and turbidity on fish range from beneficial to detrimental. Elevated total suspended solids (TSS) have been reported to enhance cover conditions, reduce piscivorous fish/bird predation rates, and improve survival, but elevated TSS has also been reported to cause physiological stress, reduce feeding and growth, and adversely affect survival. Although fish that remain in turbid waters may 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). Salmonid gill-flaring and behavioral modifications including feeding changes have been observed in response to pulses of suspended sediment (Berg and Northcote 1985) and turbidity plume avoidance has been observed in salmonids and other fish (Sigler et al. 1984, Lloyd et al. 1987, Servizi and Martens 1991).

During in-water work, any juvenile salmonid or steelhead present within the action area are most likely to experience one or more of these physical or behavioral effects from the reduction in water quality. They are likely to exhibit reduced feeding and reduced fitness. Outside the turbidity curtains during in-water construction, turbidity levels will be close to background, and we do not expect juvenile or adult fish to respond to the small water quality changes. After completing all in-water work, the removal of the turbidity curtains may result in the short-term elevated suspended sediment released beyond the immediate in-water work area. Larger fish will move out of the area with higher turbidity. Smaller juveniles that are less likely to flee may exhibit reduced feeding for a few minutes. This is not expected to reduce their fitness because there are opportunities for resting and feeding nearby. We anticipate fine sediments will dissipate and settle onto the channel substrate relatively quickly or be carried downstream. 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.

Stormwater treatment. The Columbia River within the action area is on the ODEQ 303(d) list for mercury and polychlorinated biphenyls (PCBs), pH, and temperature exceedance (ODEQ 2020). Water quality throughout the action area is degraded because of contaminants that are harmful to listed species in this opinion. Stormwater runoff from the impervious surfaces, including roads, culverts and bridges, and parking lots can deliver a wide variety of pollutants to aquatic ecosystems, such as nutrients, metals, petroleum-related compounds, sediment washed off the road surface, and agricultural chemicals used in highway maintenance (Buckler and Granato 1999; Colman et al. 2001; Driscoll et al. 1990; Kayhanian et al. 2003). These ubiquitous pollutants when discharged into waterways are a source of potent adverse effects to salmon and steelhead, even at ambient levels (Hecht et al. 2007; Loge et al. 2006; Sandahl et al. 2007; Spromberg and Meador 2006).

Currently, the stormwater draining from the parking lot surfaces is not treated and runs off into the Columbia River. The proposed design criteria for stormwater management will direct runoff and stormwater into infiltrated bioswales to prevent untreated discharge into the Columbia River waters. Techniques using low impact development, infiltrated swales, and other practices are identified as excellent treatments to reduce or eliminate contaminants for stormwater runoff [Barrett et al. 1993; Center for Watershed Protection and Maryland Department of the Environment 2000 (revised 2009); Herrera Environmental Consultants 2006; Hirschman et al. 2008; NCHRP 2006]. Treatment of stormwater will prevent contaminants and pollutants from draining into the Columbia River. The proposed action's stormwater management techniques will prevent potential untreated stormwater discharging into the Columbia River, and will improve stormwater treatment over existing conditions. Thus, following construction, stormwater from the action area is not expected to injure or harm juvenile or adult salmon or steelhead rearing or migrating through the action area.

Chemical contamination. As with all construction activities involving the use of mechanized equipment, accidental release of fuel, oil, and other contaminants may occur during construction. NMFS expects that the use of machinery will result in a small amount (not more than a few ounces) of oil and hydraulic fluid being leaked during operations. Any leak will likely be contained within the isolation area where it would have short-term adverse effects on water quality and macroinvertebrates. Operation of machinery in close proximity to a stream increases the chance a large fuel spill or hydraulic line rupture will contaminate the water. 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). If enough of the fuel or contaminant spills, it could injure or kill aquatic organisms. The proposed action will include the use of heavy equipment (an excavator) deployed on the riverbank. There is the potential for accidental spills of petroleum products or other hazardous materials into the river from this equipment.

However, based on review of past projects implemented while using similar BMPs, NMFS anticipates PAH releases of only very small quantities (ounces) are likely with each accidental release or spill. Conservation measures (staging areas, pollution control plan, and diapering of heavy equipment) will be implemented to minimize the use of toxic substances and prevent or contain any spill that may occur.

The ODEQ requires the proposed action (and the contractor) to comply with water quality requirements, daily inspection of equipment for work below the OHWM, and multiple conservation measures to maintain and protect water quality. The proposed action will limit in-water work to the winter season, when the densities of ESA-listed fish are lowest in the Columbia River. For these reasons, it is unlikely that effects of chemical contamination from the proposed action will injure or harm any juvenile or adult fish.

Substrate quality. The proposed action will excavate up to 190 cu yd and place up to 1,105 cu yd of fill within the shallow water at the project site near the Mayer State Park boat ramp. The boat ramp will be expanded by 1,453 ft^2 reducing the availability of shallow water habitat. The total disturbed area during the boat ramp and dock upgrade will extend around the project site to include an approximate total footprint of 9,996 ft^2.

Excavation will occur entirely within the in-water isolation area. Structural rock and riprap will be placed at the site for proper bank slope and elevation for the boat ramp. Excavated native substrate and materials will be placed on top of the sources riprap and rock to fill voids to mimic natural conditions. Once turbidity curtains surrounding the work area are removed, any disturbed substrate is expected to be recolonize with benthic invertebrates within a few days to weeks post implementation. The disturbed substrate area is a small size compared to the overall available shallow water habitat in the action area. We do not anticipate the small amount of benthic substrate disturbed around the boat ramp and dock will result in a significant impact to the established benthic invertebrate community at the site. The prey base will be slightly reduced for a few days up to a few weeks. Spring migrating juveniles of any DPS or ESU considered in this opinion could experience temporary, small effects of this loss. However, juvenile salmonids will feed nearby in similar habitats, and thus the effects to feeding will be small to negligible.

Ambient light/shading and increased predation. The reduction of ambient light (e.g., light attenuation and shading) is one of the primary mechanisms by which overwater (docks) and in-water structures (ramp, riprap, pilings and temporary floating barge) 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. Studies have documented use, and sometimes selection, of in- and overwater structures by predators such as smallmouth bass and northern pikeminnow (Pribyl et al. 2004; Celedonia et al. 2008). Studies in the Columbia River reservoirs have estimated juvenile salmonids account for high portions of northern pikeminnow diets (Poe et al. 1991; Zimmerman and Ward 1999; Harnish et. al 2014). The boarding dock and temporary barge may block light and provide a haven for predatory fish such as smallmouth bass and northern pikeminnow, which prey on juvenile salmonids in the Columbia River system (Vigg et al. 1991; Tabor et al. 2004; Petersen et al. 1993; Zimmerman and Ward 1999; Fritts and Pearsons 2004). Rieman et al. (1991) estimated piscivorous predators may be consuming 17% of the juvenile salmon that enter the John Day Reservoir. The shaded area 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). The temporary barge (approx. 240 ft^2) will increase shade for up to 4 days during in-water work. The small increase in the size of the boarding dock (360 ft^2), additional riprap and the extended boat ramp (265 ft^2) will result in permanent additional in-water and overwater structures and will increase shade for predator species in the shallower waters near the boat ramp. We anticipate the existing habitat quality (including riprap and fill), near the boat ramp and dock, currently provides predators hiding cover, and expose juvenile salmon and steelhead to risk of injury and death. The removal of 22 old piles in the Columbia River is expected to decrease predation and created safer passage for the ESA-listed fish in the slightly deeper waters of Salisbury Slough. This will eliminate the piles and result in less cover and shaded hiding spots for predators; and increase available safe passage and rearing areas along the Columbia River shallow water habitat. We expect the small increase of in-water and overwater structures may increase bass and pikeminnow predation success, near the boarding dock site.

We expect a few individual juvenile salmon or steelhead will experience behavior modifications (reduced feeding success, altered migration, avoidance) that may experience reduced fitness; and a few individuals may experience injury or death from a small increased in predation. The duration of this effect from increase in-water and over-water structures will increase predation of juvenile salmon and steelhead for the duration of the existence and of the dock and ramp structures. Therefore, we expect a small increase on predation from the proposed action.

Sound pressure levels and noise. Pile-driving will create short-term hydroacoustic disturbance to juvenile and adult salmon or steelhead present in the action area. Pile-driving increases SPLs and noise during construction. The project entails a pile-driver to remove the three existing boarding dock piles and install the four 12-inch-diameter steel piles. Removal and installation of the piles will occur primarily with a vibratory pile-driver and take up to 30 minutes per pile. Based on the information[2] from OPRD, the cumulative duration of peak underwater noise from pile-driving removal and installation is anticipated to be up to approximately 4 hours from vibratory driving. However, an impact pile driver may be used, only if necessary, to set the piles if substrates prevent complete installation by the vibratory driver. If an impact driver installs piles, a maximum of 50 strikes by an impact driver is anticipated. All pile-driving installation will be completed during 1 week of the in-work window. 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. These injuries resulting from compression and decompression from a sound pressure pulse are known as barotrauma (Halvorsen et al. 2012; Popper et al. 2019). Injuries from intense or continuous underwater sound pressure can include damage to the auditory system. This can result in a temporary or permanent loss of hearing known as either a "temporary threshold shift " (Carlson et al. 2007) or a long-term "permanent threshold shift" (Liberman 2016). The level of injuries can vary based on the intensity and characteristic of the high pressure, distance to the pressure source, the size and species of the fish (Hastings and Popper 2005, CalTrans 2020). Barotrauma injuries can include external and internal damage including bulging eyes, ruptured organs and swim bladders, hemorrhaging and death (Brown et al. 2009, Brown et al. 2012; Halvorsen et al. 2012) Fish respond differently to sounds produced by impact drivers than to sounds produced by vibratory drivers. Vibratory drivers produce a more rounded sound pressure wave with a slower rise time. Because the more rounded sound pressure wave produced by vibratory drivers produces a slower increase in pressure, the potential for injury and mortality is reduced.

[2] Email correspondence dated 9/20/2021, between Rebeca Viray (NMFS) and Darrell Monk (OPRD) regarding total vibratory pile driving for boarding dock removal and installation.

The Fisheries Hydroacoustic Working Group (FHWG), multi-agency work group, determined SPLs where fish are likely to experience effects from pile-driving activities (FHWG 2008). Instant injury or death can occur from levels at or above 206 decibels (dB) peak (single strike) Injury to fish larger than 2 grams occurs at 187 dB sound exposure level (SEL), and at 183 dB SEL where fish are smaller than 2 grams for cumulative strikes. In addition, a "harassment" threshold above SPLs of 150 dB is applied for where behavioral effects or potential physical injury (i.e. harm) to individual salmon or steelhead within a distance of the source may occur (Popper et al. 2006; FHWG 2008).

We anticipate fish will experience behavioral modifications from sounds generated through vibratory driving as fish flee the vicinity. Impact pile-driving can produce underwater sound pressure waves that can have effects on fish, varying upon the variables of: type and intensity of sounds, size of the piles, firmness of the substrate, water depth, and the type and size of the pile-driver. Larger piles and firmer substrate require greater energy to drive the pile, resulting in higher SPLs. This is a relationship between driven energy and its transformation into overcoming friction or resonance. Hollow steel piles produce higher SPLs than similarly-sized wood or concrete piles (Hastings and Popper 2005). Sound attenuates more rapidly in shallow water than in deep waters (Rogers and Cox 1988). However, fish with swim bladders and smaller fish, which tend to be in shallower water, have been shown to be more vulnerable to injury (Hanson et al. 2003).

Impact Pile-Driving. For this project, we reviewed projects with comparable data or pile sizes installed at similar project and sites on the Columbia River mainstem, and reviewed information provided in the BA. The BA used the NMFS hydroacoustic calculator and data from the Washington State Department of Transportation (WSDOT 2016) to determine distances individual fish may encounter noise from impact pile-driving that results in effects to that fish. The calculator used baseline single strike levels of 207 dB peak, 173 dB SEL, and 189 dB root mean squared (RMS) for a 12-inch-diameter steel piling measured at 10 meters (m) and a default transmission loss constant of 15 m. However, NMFS hydroacoustic calculator method is a conservative method to determine the maximum distance away from the sound pressure source where direct injury or behavioral modifications may effect listed species. Popper et al. (2019) studied the onset of tissue injury on juvenile Chinook salmon and found the number of injuries and severity increased as the single strike SEL and cumulative SEL increased. Based on the calculations for this project, the instant physical injury or death would occur up to a maximum distance of 10 ft. (3 m) from the pile. The project anticipates at the maximum, if all work requires pile installation by impact driver, there will be a maximum of 50 pile cumulative strikes total applied over the course of one day. We expect cumulative injury or the onset or auditory tissue injury for fish greater than 2 grams (juvenile salmonids present in the action area will be greater than 2 grams) may occur within 20 ft. (6 m). Based on fork length data of juvenile salmonids passing through the Columbia River presented by Cooney (2002) and the length curves presented by MacFarlane and Norton (2002) and Duffy (2003), juvenile salmonids in the action area will be heavier than 2 grams. The NMFS hydroacoustic calculator determined the "harassment" threshold where fish may experience potential behavioral effects or potential injury may occur within a distance of approximately 2,815 ft. (858 m).

All pile-driving will occur within the in-water isolation area, after the turbidity curtain has been installed and most fish have been herded out of the work area. This will reduce potential direct injury or death to individual listed fish present within the radius where SPLs will extend. The applicants will use a bubble curtain during any impact driving installation. This will reduce potential direct injury or death to individual listed fish present within the radius where SPLs will extend. The proper use of a sound attenuating device (confined bubble curtain) can result in reductions in SPLs depending on the type of impact driver and site specific conditions, potentially reducing effects to listed species during pile-driving (Wursig et al. 2000; Rodkin and Pommerenck 2014; CalTrans 2020). We expect the installation of the in-water isolation area, and the use of a bubble curtain will reduce the likelihood of fish being in close proximity to impact pile-driving.

The installation of the turbidity curtains around the in-water construction will reduce the potential of fish injured or killed from interactions with pile-driving equipment. We anticipate if an impact driver will be needed, a few individual juvenile salmon and steelhead of any of the ESUs and DPSs may encounter hydroacoustic SPLs during impact pile-driving that will injure or kill them. We anticipate a small number of adult steelhead will overwinter in the mainstem Columbia River in the action area. A few individual adult Chinook migrate through the Bonneville Reservoir starting mid-March and could be within the action area. We do not expect adult SR-fall Chinook present during the winter IWWW. Adult salmon and steelhead area anticipated to flee during the turbidity curtain installation, and adults are not anticipated to be present within the in-water work area during pile-driving.

We do not anticipate any instant physical injury or death to juvenile salmon or steelhead to occur from impact pile-driving outside of the turbidity curtains. We anticipate any individual salmon and steelhead greater than 2 grams and present with 10 ft. from the site of impact driving will be injured or killed. To determine the amount of juvenile salmon or steelhead that may be exposed to direct injury or death from pile-driving activities we considered both the distance of potential injury from onset of impact pile-driving, in combination with the potential mechanical injury and death from interactions with heavy equipment within the in-water isolation area, as previously described. We anticipate any fish exposed to risk of injury or death from pile-driving will also be exposed to injury or death from in-water construction. Therefore, our estimate of any juvenile salmon or steelhead injured or killed from impact pile-driving activities is included in our amount of injured or killed fish previously described above, 29 juvenile Chinook salmon and 15 juvenile steelhead. The fish injured or killed will likely be distributed among the remaining populations of each ESU and DPS that could be present. We do not expect the number of juvenile fish killed to be a significant amount to affect the abundance of any population of ESA-listed salmon or steelhead considered in this opinion.

Vibratory Pile-Driving. It is difficult for NMFS to determine the type of response each individual fish will make. However, vibratory pile-driving is reasonably certain to alter individual 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. NMFS anticipates the majority of fish will respond by adjusting their behavior.

The use of a vibratory driver will greatly reduce the level of noise associated with the work, if feasible. We anticipate some individual fish may experience behavioral modifications including reduced feeding success, altered migration, altered reaction time, and increased exposure risk to predators from avoiding elevated SPLs during vibratory pile-driving (CalTrans 2020). These behavioral modifications may reduce the fitness of a few juvenile salmon or adult or juvenile steelhead to a point where a few fish may experience delayed injury or increase exposure to death. NMFS does not believe that this response to vibratory driving will result in immediate direct injury or death to juvenile salmon or steelhead.

Reduced access and passage from in-water work isolation area. A turbidity curtain will be installed starting from the shoreline and deployed out to create an in-water isolation area surrounding the boat ramp and dock. The effort to herd fish out of the in-water work area during net deployment will reduce the presence of salmon or steelhead from within the in-water work area. The installation of the turbidity curtain will create an in-water isolation area (12,700 ft^2), limiting fish access to the work area. The presence of turbidity curtain will prevent juvenile salmon or steelhead from accessing the isolation area of the Columbia River. However, this area is a back channel slough of the Columbia River and during the winter work window is not expected to be used by adult salmonids. Project implementation will occur during the winter season; we anticipate the fewest number of juvenile salmon or steelhead would be potentially present or rearing in the project area. We expect a few individual juvenile steelhead will experience behavior modifications as they swim around the temporary work isolation area (reduced feeding success, altered migration, avoidance) but we do not anticipate this will alter the fitness of juvenile salmon or steelhead.

Increase recreation use at the boat ramps. Improvements and upgrades to the boat ramp and boarding dock will provide safer and easier access for public recreational opportunities and boat access at Mayer State Park. The improvements to the boat ramp will allow users to launch at a wider range of reservoir elevations. These improvements and easier access for public recreational users may create an increased use of the boat ramp and dock. The additional recreational use may result in a very small increase in some noise and human disturbance within and near waters with ESA-listed species over a long time frame, many years into the future. Additional human activity at or near the boat launch and boarding float could disturb salmon or steelhead that may be in the vicinity. However, it is difficult to determine if the increase in use would be related to the improvement of the boat launch facility or changes in population or even some other variable. We anticipate any salmon or steelhead near the boat launch and floating dock may experience behavior modification and likely flee the area due to any noise disturbance from recreational use at the boat ramp or dock. Therefore, it would be hard to discern changes in salmonid behavior above existing conditions that are solely related to the boat ramp or boarding float improvements. We do not anticipate any increase in the boat ramp use or dock would result in direct injury or kill individual salmon or steelhead.

Summary

We estimate that 29 juvenile Chinook salmon and 15 juvenile steelhead will be killed or injured from in-water construction activities and pile driving. Juvenile salmon and steelhead present within the in-water work area will likely experience temporary behavioral modifications due to elevated sediments and turbidity during in-water construction. The additional in-water and overwater structures are anticipated to result in a very little change in exposure to injury or death from predation compared to current existing conditions. The new stormwater treatment methods are expected to improve water quality at a local scale.

2.5.3. Effects on Critical Habitat

The critical habitat PBFs most likely to be affected are substrate, water quality, forage, and safe passage.

Substrate
Approximately 9,996 ft^2 of near-shore, shallow-water benthic habitat will be disrupted by excavation (up to maximum 16 ft. deep) and fill during in-water construction to replace the boat ramp and dock. The substrate is composed of cobble, course sand, and depositional materials that provide habitat for benthic invertebrates and forage prey. Approximately 190 cu yd of native substrate and material will be removed from the substrate of the Columbia River and 1,105 cu yd of fill, riprap, and native substrates will be placed below OHWM and the river channel. A crane and strap will vertically remove 22 old piles, and a pile-driver will remove the existing three piles and install four new steel piles. These activities will disrupt established substrate. The installation of the four new 12-inch-diameter steel piles will permanently remove approximate 4 ft^2 of channel substrate. However, the removal of the old pilings will remove in-water structures and restore approximately 22 ft^2 of shallow water habitat. The new boat ramp will be additional permanent in-water structure and occupy an additional 265 ft^2 of channel substrate. Overall, this disturbance to substrate is a very small portion of the available habitat in the Bonneville Reservoir. Increased turbidity from project activities will result in sediment deposition downstream of the in-water work area, which has the potential to adversely affect primary and secondary productivity (Spence et al. 1996) for a short time period during and immediately following in-water work. Excess fine sediment in the action area is expected to occur over a small area and is likely to be transient, as daily and seasonal increases in water velocity remobilize and redeposit these sediments in slower moving portions of the reservoir. The scale of impact will be minimal relative to the rearing habitat in the action area, and will not meaningfully change the conservation value of substrate within the Bonneville Reservoir.

Water Quality
The proposed action will have a short-term (up to 2 months) negative effect on water quality by increasing suspended sediment and turbidity during construction; this will occur during the in-water construction within the in-water work area. Additionally, an area downstream of the in-water work area will have increased suspended sediment for minutes to hours after the turbidity curtains are removed. Excess suspended sediment and increased turbidity will likely settle out in some areas with low velocity within the work area, or may settle or disperse to downstream areas. Thus, any increased turbidity pulse following removal of the turbidity curtains removal will quickly settle into low velocity areas or become mixed with the river and be indistinguishable from background levels. In addition to the turbidity curtains, OPRD proposes to use erosion and sediment measures to reduce excess turbidity and suspended fine sediments from upland construction. NMFS anticipates any excess turbidity will dilute and disperse with the river current and not be distinguishable from background levels down current of the proposed action.

The use of heavy equipment may result in very small amounts of pollutants entering waterways as discussed above. However, the project will use conservation measures (storage and fueling of lubricants, fuels in designated areas, hazardous and spill plans) to minimize and limit effects of chemical contamination reducing water quality. With these measures, it is unlikely chemical contamination from heavy equipment use will have more than a minimal effect to water quality and will not reduce the conservation value of the action area.

The project will install stormwater treatment swales to prevent untreated runoff generated from parking lots or impervious surfaces from directly discharging into the Columbia River. The treatment of stormwater will reduce pollutants entering the waterbody, and will support the conservation value of water quality in the action area.

Given the BMPs, erosion control methods, a PCP, and the use of the IWWW, NMFS believes that the effects to water quality will not meaningfully decrease the function of this PBF 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 boat ramp and boarding dock. We expect nearby benthic macroinvertebrates will begin to recolonize within several days to weeks, and will fully recolonize the area within a few months after project completion. The alteration of this small amount of habitat could have some minimal localized effects to forage for out-migrating and rearing juvenile salmonids and steelhead that use this nearshore area during construction, and for up to several weeks after project completion. However, we do not anticipate the localized reduction in available forage will have a significant or long-term impact to the quality of habitat. Given the size of the reservoir, the amount of available local nearshore habitat, and the small and short-term nature of the effect, NMFS does not anticipate that this project will change the conservation value of forage in the Bonneville Reservoir.

Safe Passage

The proposed action will create short-term and long-term alteration of PBFs for passage. Short-term safe passage will be reduced during the 8-week in-water construction period when the in-water work isolation area is present. This construction will occur at a time when very few fish of any species will be migrating either upstream or downstream.

The increase of 360 $ft.^2$ of additional permanent over-water structures and 265 $ft.^2$ of in-water structures will create additional cover where predators may hide. This may result in a small increase risk to juvenile salmonids from additional exposure to additional predation. Bass and northern pikeminnow are predators on juvenile salmonids. The proposed action’s additional permanent over-water and in-water structures may increase bass and pikeminnow predation success, and could minimally reduce juvenile salmon and steelhead passage success. However, that will be partially offset with the removal of 22 piles from Salisbury Slough.

We expect both the short-term and long-term alteration of passage will occupy only a small footprint, around which migration in either direction will be unimpeded. We expect this alteration of the PBFs for safe passage due to the new in-water and over-water structures will be permanent.

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 vs. cumulative effects.

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 in-stream 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 ESA-listed salmonid and steelhead are anticipated with population growth, urban development, and increases in recreational use of the Columbia River. The population of Wasco County, Oregon, grew 6.3%[3] from 2010 to 2019. NMFS assumes the population for Wasco County will continue to grow for the foreseeable future. As the human population in the action area grows, demand for agricultural, commercial and residential development, and recreation is likely to increase as well. Industrial and commercial development often 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.

Although these are ongoing and likely to continue in the future, the future rate of development will depend on whether there are economic, administrative, and legal factors that can either support or restrict development (or in the case of contaminants, safeguards). Therefore, although NMFS finds it likely that, the cumulative effects of these activities will have adverse effects commensurate to those of similar past activities; it is not possible to quantify these effects. Some of these future activities will require a Federal permit, and thus will undergo ESA consultation. Many future State or tribal actions would likely have some form of Federal funding or

[3] U.S. Census Bureau. Available at: https://www.census.gov/quickfacts/wascocountyoregon.

authorization and therefore would be reviewed by NMFS. This limits the scope of cumulative effects that can be factored in this analysis.

Based on the analysis above, the cumulative effects of future State and private activities will have a continued negative effect on ESA-listed fish and their habitats.

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 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.

2.7.1. 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, the major sources of impacts to salmon and steelhead are hydropower dam systems as well as the continued development and maintenance of the shoreline including marinas, docks, roads, railroads, and riprap. Dams and reservoirs within the migratory corridor have altered the river environment and affected fish passage. 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, exacerbated in some locations (by providing perch sites or hiding spots for predators) by development. 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 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 to have negative effects on ESA-listed salmonids.

Climate change is likely to affect the abundance and distribution of the ESA-listed species considered in the opinion. The exact effects of climate change are both uncertain, and unlikely to be spatially homogeneous, and the ability of listed-species to adapt is uncertain. Most of the effects of the action are short term, and thus will not exacerbate the effects on species and habitat caused by climate change. Future potential water temperature rises may increase favorable conditions for piscivorous fish species. The long-term effects of predation risk from over-water structures is likely to continue and the degree of the effect to predation risk may be altered by climate change remain uncertain.

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 the single extant SR sockeye salmon population, have an overall viability rating of high risk. The other five species are listed as threatened, and while some populations are viable, most populations within these ESUs/DPSs remain at moderate or high risk of extinction.

NMFS anticipates the proposed action will affect juvenile UCR spring-run Chinook salmon, UCR steelhead, MCR steelhead, SRB steelhead, SR spring/summer-run Chinook salmon, and SR fall-run Chinook salmon within the active in-water work area during the winter months. We do not expect juvenile SR sockeye salmon to be present in the action area during the IWWW. However, an individual juvenile sockeye may on occasion be rearing in the Bonneville Reservoir. Smaller juvenile fish that are less likely to flee may experience passage alteration if delayed within the in-water isolation area and are likely to die or be injured by equipment, pile-driving or high levels of turbidity. Based on our calculations, we expect the in-water construction or pile-driving activities may injure or kill a maximum up to 29 juvenile or subyearling Chinook salmon, and up to 15 juvenile steelhead from any of the ESUs/DPSs. The in-water work area is a small area and will affect only a few individuals of any population of each species. Adult UCR, MCR and SRB steelhead are the most likely to be in the Bonneville Reservoir in the winter work window, and they are highly likely to avoid the disturbance caused by the construction. Adult steelhead are migrating or holding in the reservoir in the winter, and the avoidance behaviors are not expected to reduce their fitness because there is other similar habitat in the vicinity. A few individual adult UCR spring-run Chinook and SR spring/summer Chinook salmon may migrate through the action area beginning mid-March. We do not anticipate adult SR fall-sun Chinook or adult SR sockeye salmon will be present during the IWWW.

In addition to direct injury or death, juvenile salmonids may be harmed during and in the few months following construction because of the following:

- Temporary reduction in available forage may disrupt established macroinvertebrate communities.
- Vibratory pile-driving may create behavioral modifications as juveniles flee the area.
- Increased turbidity may disrupt normal feeding activities of juveniles and displace them to other areas of the reservoir.

These effects will be minor, temporary (days to a maximum of 8 weeks), and will affect all populations of juvenile salmonids that are present in the Bonneville Reservoir during the winter work window.

In addition to these short-term effects, there are likely to be long-term consequences of the proposed action. The additional new in-water and over-water structures may result in an increase of exposure risk to predation for juveniles of all the species over the long-term existence of the structure. Removal of the existing 22 piles from the Columbia River will partially mitigate for the increase in over-water structures, and will improve natural shallow water habitat and safe passage for juvenile salmon and steelhead. The installation of stormwater treatment methods will improve water quality and reduce the potential of future pollutants discharged into the Columbia River.

Considering the effects of the action in conjunction with 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 will 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 appreciably 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.

2.7.2. 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 primary effects of the action will be short-term construction-related effects, and the long-term alteration of safe passage from additional in-water structures in the Columbia River. NMFS expects adverse effects to the above PBFs from the reduced water quality, temporary disturbance of the substrate and shallow-water benthic habitat, which will cause a temporary change to prey availability in the disturbed area. Increases in TSS and turbidity during project construction are expected to be high within the in-water isolation area. Once the in-water work area is removed, water quality will be impaired by an increased turbidity that may extend downcurrent of the excavation area, and last for up to a few hours. Background levels of turbidity in the Bonneville Reservoir are quite high, and this temporary increase in turbidity in a small area of the river will not change water quality at the scale of the critical habitat designations.

Benthic disturbance in the excavation area will reduce prey availability. However, the area of excavated substrate is very small, and the prey invertebrates will start to recolonize as soon as construction is done. Recolonization will occur over a couple of weeks. The increase in in-water and over-water structures may slightly reduce safe passage at the immediate area near the boat dock and ramp. However, removal of the old pilings will improve safe passage in the nearby site within the Salisbury Slough of the Columbia River. The disturbed area is a small fraction of similar quality, shallow habitat area available for use in the Bonneville Reservoir.

Based on our analysis that considers the current status of PBFs, 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 of the scale and extent of the effects to PBFs, we do not expect a reduction in the conservation value of critical habitat in the action area. As we scale up from the action area to the designation of critical for each species, the proposed action is not expected to appreciably reduce the conservation value of the designated critical habitat.

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 the seven species considered in this opinion, or destroy or adversely modify their designated critical habitat.

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 the biological opinion, NMFS determined that incidental take is reasonably certain to occur as follows: (1) behavioral changes due to increased turbidity and in-water disturbance;
(2) mechanical injury or death from in-water work equipment; (3) behavioral changes, injury or death from hydroacoustic disturbance generated from vibratory or impact pile-driving activities; and (4) increased injury or death from predation. NMFS is reasonably certain the incidental take described here will occur because: (1) ESA-listed species are known to occur in the action area; and (2) the proposed action includes in-water activities that are reasonably certain to harm or kill juvenile steelhead and salmon.

We anticipate the proposed action may result in harm, harassment, injury or death to juvenile salmon or steelhead from any of the DPSs and ESUs within the active in-water construction area. Subyearling Chinook salmon and juvenile steelhead are the most vulnerable and likely to be exposed to injury or death while rearing in shallow water habitat during the IWWW. Although juvenile SR sockeye salmon are least likely to be present during the in-water construction, an individual fish may occasionally rear in the winter. Based on the timing and shallow water depths adult steelhead (SRB, MCR, and UCR) are more vulnerable and a small number of fish are likely to be present in Bonneville Reservoir during the in-water work. A small number of adult Chinook may be migrating through the action area during the end of the IWWW. Adult UCR spring-run and SR spring/summer Chinook salmon are least vulnerable to effects from construction. Adult sockeye salmon and SR fall-run Chinook salmon are not anticipated to be in the project area during in-water construction. Adult salmon and steelhead area anticipated to flee from the in-water work area during installation of the in-water isolation area. All juvenile salmon and steelhead of any ESUs/DPSs are anticipated to be exposed to long-term increased risk of injury or death from predation risk due to the increase in permanent over-water structures.

Incidental Take from Increased Turbidity and Disturbance
NMFS expects salmon and steelhead to be temporarily displaced and may have reduced feeding (harm) due to elevated turbidity levels resulting from in-water work associated with the removal and excavation of the existing in-water and overwater structures, and installation for the new upgraded ramp and boarding dock. Because it is not feasible to observe fish harmed, NMFS will use the extent and excess turbidity monitoring levels as a surrogate for take resulting from degraded water quality. These indicators are causally linked to incidental take from in-water construction including: excavation, removal and installation of pilings, boat ramp and boarding dock installation in waters containing the seven species covered in this opinion. We use the extent and duration of the turbidity plume because the amount of take increases as turbidity associated with the in-water work increases in extent and duration. Therefore, NMFS will consider the extent of take exceeded if a turbidity monitored 50 NTU during project construction (as measured consistent with ODEQs required water monitoring during in-water work) or exceeds 10% of background measurements 100 ft. downstream of the in-water work area when monitored every 2 hours during in-water work.

Incidental Take from Mechanical Injury or Death
NMFS anticipates the proposed action will result in injury or death as a result of in-water excavation and fill. Estimating the specific number of animals injured or killed by interactions with heavy equipment is not possible because of the range of responses that individual fish will have, and because the numbers of fish present at any time is highly variable. While this uncertainty makes it difficult to quantify take in terms of numbers of animals injured or killed, our best estimate anticipated no more than 29 juvenile Chinook salmon and 15 juvenile steelhead may experience injury or death during in-water work within the isolation work area. We anticipant locating and finding all potential injured or killed fish maybe impossible and hard to track. However, the extent of habitat altered by excavation and installation boat ramp, pilings, and boarding dock 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 encompassed by excavation and filling represents the extent of take associated with mechanical injury and death. The proposed surrogate is causally linked to anticipated take because it describes conditions that will cause take due to in-water work. Specifically, NMFS will consider the extent of take exceeded if the limits excavate up to 200 cu yd and place up to 1,150 cu yd of fill. This amount includes a small amount or margin of error above the proposed action that we considered would not have additional anticipated effects.

Incidental Take from Hydroacoustic Sound Pressure Levels during Pile-Driving
NMFS expects the proposed action will result in harm, harassment, injury or death to salmon and steelhead by exposure to hydroacoustic SPLs during vibratory and impact pile-driving activities. Salmon and steelhead experience behavior modifications (harm) through reduced feeding success and altered migration from avoiding elevated SPLs during vibratory pile-driving. The modifications may result in reduced fitness and survival to any juvenile steelhead or salmon

present. Impact pile-driving can result in injury or death to any fish present in the vicinity out to 10 ft. from the steel pile installation.

Estimating the specific number of animals injured or killed by pile-driving is not possible because of the range of responses that individual fish will have and because the numbers of fish present is highly variable. While this uncertainty makes it impossible to quantify take in terms of numbers of animals injured or killed, the duration of the pile-driving activities to which 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 duration of vibratory pile-driving (excess of 4 hours) or the total number of strikes (excess of 50 strikes) by an impact pile driver represents the extent of take associated with hydroacoustic SPLs during impact pile-driving activities. The proposed surrogate is linked to anticipated take because it described conditions that will cause take due to fish experiencing behavioral modifications during either vibratory pile-driving, or injury or death from impact pile-driving during the in-water pile installation activities. Specifically, NMFS will consider the extent of take exceeded if construction includes above 4 hours of vibratory pile-driving, or exceeds 50 strikes per day by an impact pile-driver.

Incidental Take from Increased Predation
NMFS expects the proposed action will result in harm, harassment, injury or death to juvenile salmon and steelhead by increases in exposure to piscine predators. Salmon and steelhead fleeing from predators may experience behavior modifications (harm) through reduced feeding success and altered migration from avoiding predators (harassment). The modifications may result in reduced fitness and survival to any juvenile steelhead or salmon present. We expect injury or death of juvenile salmon and steelhead from increased predators due to the increase in ambient light and shade from the additional increase in permanent in-water structures. We expect some juvenile salmon and steelhead will experience direct injury or be killed from increased interactions with predators.

Estimating the specific number of animals injured or killed annually by increased predation is not possible because of the range of responses that individual fish will have, and because the numbers of fish present is highly variable both spatially and temporally. While this uncertainty makes it impossible to quantify take in terms of numbers of animals injured or killed, the extent of the permanent change in habitat to which fish will be exposed is readily discernible and presents a reliable measure of the extent of take that can be monitored and tracked.

The increased predation associated with new permanent additional in-water and over-water structures (265 ft^2 and 360 ft^2) will likely occur as long as the boarding ramp and dock exists. Therefore, the increased predation from the additional permanent structures is best represented by the size of the footprint the new structures will occupy. The proposed surrogate is linked to anticipated take because it describes both the amount of area of changes in habitat 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 the extent of take exceeded if the overall amount of the increase in new in-water and over-water structures (ramp and boarding dock) area exceeds 625 ft^2. Therefore, the increase in the areas of the new in-water structures represents the extent of take exempted from increased predation in this ITS.

The surrogates described above are measurable, and thus can be monitored and reported. For this reason, the surrogates function as effective reinitiation triggers.

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, destruction, or adverse modification of critical habitat.

2.9.3. Reasonable and Prudent Measures

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

1. Avoid or minimize take from habitat disturbance and mechanical injury.
2. Avoid or minimize take from reduced water quality.
3. Avoid or minimize take from injury or death from pile-driving activities.
4. Avoid or minimize take from increased predation.
5. Conduct sufficient monitoring to ensure that the project is implemented as proposed, and the 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

In order to be exempt from the prohibitions of section 9 of the ESA, the Federal action agency must comply (or must ensure that any applicant complied with the following terms and conditions. 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. The following terms and conditions implement RPM 1:
    a. A fishery biologist will supervise during installation of the turbidity curtains for the in-water isolation area.
    b. A fishery biologist experienced with work area isolation and competent to ensure the safe capture, handling and release of any observed fish will be consulted; and will supervise and determine the feasibility of fish salvage and relocation within the in-water isolation area
    c. Any fish trapped within the isolated work area must be captured and released using a trap, seine, electrofishing, or other methods as prudent to minimize the risk of injury, then released at a safe release site.

2. The following terms and conditions implement RPM 2:

   a. Conduct turbidity monitoring as follows:
      i. All in-water construction shall be conducted following the proposed sediment control measures and follow State and Federal water quality requirements to minimize sedimentation and turbidity in the Columbia River.
      ii. Monitoring will be conducted daily, each 2 hrs monitoring interval 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 baseline turbidity measurements upstream of the action area.
      iv. Background measurements will be measured or observed at an undisturbed site within the flow channel approximately 100 ft upcurrent of the project area.
      v. Compliance measures will be measured or observed in the flowing channel approximately 100 ft. downstream from the project area. Turbidity measurements should not exceed above 10% of the background measurements or 50 NTU. If turbidity is exceeded, BMPs will be modified and additional sediment control measures will be installed to minimize downstream increase of turbidity and fine sediments.
      vi. Properly sized turbidity curtains will be used to ensure that the curtains remain in constant contact with the substrate, and span the entire water column. Monitoring will be continued every 2 hours. If turbidity exceedance over background level measurements occurs, work shall be modified and monitored every 2 hours. If an exceedance continues after the seconding monitoring interval, the activity must be stopped until the turbidity level returns to baseline conditions.
   b. All structural rock, riprap and fill material should be clean, and free of contaminants prior to placement below OHWM.

3. The following terms and conditions implement RPM 3:

   a. Drive each piling as follows to minimize the use of force and resulting sound pressure:

      i. Use the smallest driver and the minimum force necessary to complete the job.
      ii. Use a drop driver or a hydraulic impact driver whenever feasible, and set the drop height to the minimum necessary to drive the piling.
      iii. When possible, place a block of wood or other sound dampening material between the driver and the piling being driven.
      iv. If water velocity is 1.6 fps or less, surround the piling being driven by a confined or an unconfined bubble curtain that will distribute small air bubbles around 100% of the piling perimeter for the full depth of the water column.
      v. If water velocity is greater than 1.6 fps, surround the piling being driven by a confined bubble curtain (e.g., a bubble ring surrounded by a fabric or metal sleeve) that will distribute air bubbles around 100% of the piling perimeter for the full depth of the water column.

4. The following terms and conditions implement RPM 4:

   a. All installed dock piles will be installed with conical shaped caps if their height extends above the boarding dock surface.
   b. Effort should be made to evaluate the feasibility to install a 50% light-penetrating grated material on the boarding dock surface.

5. The following terms and conditions implement RPM 5:

   a. Track and monitor construction activities (as described below) to ensure that the conservation measures are not exceeding the authorized extent of take.
   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. Details of total footprint of disturbed area during in-water construction to ensure meeting the extent of take requirements.
      iii. Summary and details of turbidity monitoring including:
         a. Any daily observed turbidity monitoring from the in-channel work area down current during the in-water construction period. Observations shall occur daily before, during and after commencement of construction activities and compared to observable turbidity.
         b. Description of the visually monitored downstream extent of turbidity plumes resulting from in-water construction and excavation activities, including removal of the in-water turbidity curtains.
         c. A summary of turbidity monitoring results, including results of implementing required BMPs, and including a description of any erosion control failure, excess turbidity release, and efforts to correct such incidence.
      iv. Summary and details of pile-driving activities including:
         a. Description of the total details of actual pile-driving implementation for installation of piles by both vibratory and impact-driving methods.
         b. Total hours of vibratory driving methods and total number of impact hammer strikes to install piles.
      v. Photos of habitat conditions (open water including sediment control measures, 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. Provide and record the number and species of any observed injured or dead listed salmon or steelhead found at the in-water work site.
   c. All reports will be sent to:

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

      i. Reference to NMFS consultation number WCRO-2021-01784
   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. Work with OPRD and other stakeholders in the Columbia River Basin to increase education, outreach projects and restoration of habitat in the stream or river for fish, to conserve, protect and benefit fish and aquatic resources.

2.11. Reinitiation of Consultation

This concludes formal consultation for the Mayer State Park Boat Ramp and Facility Improvements.

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. Under the MSA, this consultation is intended to promote the conservation of EFH as necessary to support sustainable fisheries and the managed species' contribution to a healthy ecosystem. For the purposes of the MSA, EFH means "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity", and includes the physical, biological, and chemical properties that are used by fish (50 CFR 600.10). 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) of the MSA also requires NMFS to recommend measures that can be taken by the action agency to conserve EFH. Such recommendations may include measures to avoid, minimize, mitigate, or otherwise offset the adverse effects of the action on EFH [CFR 600.905(b)]

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 Pacific Fishery Management Council 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. kisutch*) (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, substrate, benthic communities, and habitat connectivity.

The proposed project includes excavation of channel substrate, pile-driving and installation of the new piles, boat ramp and boarding dock beneath the substrate of the Columbia River. This will alter approximately 9,996 ft^2 of river bottom, altering benthic habitat and macroinvertebrate production. This action will result in disturbance of sediments and increased turbidity resulting in short-term adverse effects to water quality and feeding habitat.

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

1. The temporary alteration of the near-shore environment by excavation and placement of structures within the channel substrate, which will temporarily (during construction) affect juvenile rearing and, the quality of habitat in the migration corridor.
2. Temporary reduction in prey availability from removal and disturbance of the macroinvertebrate community and as a result of excavation and increased fine sediment in stream substrates due to instream work.
3. Short-term elevation of turbidity and sedimentation within and immediately down-current from the construction area from construction activities.
4. Habitat disturbance due to vibratory and possibly impact pile-driving (hydroacoustic impacts). The sound associated with pile-driving alters the physical properties of the habitat, temporarily 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, RPM 2 and RPM 5, 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 5(b), 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, 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 time frames for the Federal agency response. The response must include a description of the 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 users of this opinion are the Corps and OPRD. Other interested users could include consultants, contractors, and the citizens of

Wasco County. 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 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 MSA implementation, and reviewed in accordance with West Coast Region ESA quality control and assurance processes.

5. References

Barrett, M. E., R. D. Zuber, E. R. Collins, J. F. Malina, R. J. Charbeneau, and G. H. Ward (editors). 1993. A review and evaluation of literature pertaining to the quantity and control of pollution from highway runoff and construction. 2nd edition. Center for Research in Water Resources, Bureau of Engineering Research, University of Texas at Austin. Austin.

Battin, J., M. W. Wiley, M. H. Ruckelshaus, R. N. Palmer, E. Korb, K. K. Bartz, and H. Imaki. 2007. Projected impacts of climate change on salmon habitat restoration. Proceedings of the National Academy of Sciences of the United States of America 104(16):6720–6725.

Beeman, J. W., and A. G. Maule. 2006. Migration depths of juvenile Chinook salmon and steelhead relative to total dissolved gas super saturation 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.

Brown, R. S., T. J. Carlson, A. E. Welch, J. R. Stephenson, C. S. Abernethy, B. D. Ebberts, M. J. Langeslay, M. L. Ahmann, D. H. Feil, J. R. Skalski, and R. I. Townsend. 2009. Assessment of barotrauma from rapid decompression of depth-acclimated juvenile Chinook salmon bearing radiotelemetry transmitters. Transactions of the American Fisheries Society, 138(6):1285–1301.

Brown, R. S., T. J. Carlson, A. J. Gingerich, J. R. Stephenson, B. D. Pflugrath, A. E. Welch, M. J. Langeslay, M. L. Ahmann, R. L. Johnson, J. R. Skalski, A. G. Seaburg, and R. L. Townsend. 2012. Quantifying mortal injury of juvenile Chinook salmon exposed to simulated hydro-turbine passage. Transactions of the American Fisheries Society, 141(1):147–157.

Buckler, D. R., and G. E. Granato. 1999. Assessing biological effects from highway-runoff constituents. U.S. Geological Survey, Open File report 99-240. Northborough, Massachusetts. 45 p.

CalTrans (California Department of Transportation). 2020. Technical guidance for assessment of the hydroacoustic effects of pile-driving on fish. Department of Environmental Analysis, Environmental Engineering. Sacramento, California. Available online at: https://dot.ca.gov/-/media/dot-media/programs/environmental-analysis/documents/env/hydroacoustic-manual.pdf

Carlson, T., M. Hastings, and A. N. Popper. 2007. Update on Recommendations for Revised Interim Sound Exposure Criteria for Fish during Pile Driving Activities. Memorandum to Suzanne Theiss (California Department of Transportation) and Paul Wagner (Washington State Department of Transportation).

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, Lacey.

Center for Watershed Protection, and Maryland Department of the Environment. 2000 (revised 2009). 2000 Maryland stormwater design manual: Volumes I and II. Maryland Department of the Environment. Baltimore.

Colman, J. A., K. C. Rice, and T. C. Willoughby. 2001. Methodology and significance of studies of atmospheric deposition in highway runoff. U.S.G. Survey, Open-File Report 01-259. Northborough, Massachusetts. 63 p.

Columbia River DART. Columbia Basin Research. 2021. University of Washington, Seattle.

Cooney, T. 2002. Briefing Paper: Estimating Survival of Anadromous Fish through the Mid-Columbia PUD Hydropower Projects.

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. M. McClure, T. Beechie, S. J. Bograd, D. A. Boughton, M. Carr, et al. 2019. Climate vulnerability assessment for Pacific salmon and steelhead in the California Current large marine ecosystem. PLOS ONE 14(7). https://doi.org/10.1371/journal.pone.0217711

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.

DOC (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.

Driscoll, E. D., P. E. Shelley, and E. W. Strecher. 1990. Pollutant loadings and impacts from highway runoff, Volume III: Analytical investigation and research report. Federal Highway Administration, Office of Engineering and Highway Operations Research and Development. FHWD-RD-88-008. McLean, Virginia.

Duffy, E. J. 2003. Early marine distribution and trophic interactions of juvenile salmon in Puget Sound. University of Washington, Seattle. Feely, R. A., T. Klinger, J. A. Newton, and M. Chadsey (editors). 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.

FHWG (Fisheries Hydroacoustic Working Group). 2008. Agreement in Principal for Interim Criteria for Injury to Fish from Pile-driving Activities. Memorandum dated June 12, 2008.

Ford, M. J. 2011. Status review update for Pacific salmon and steelhead listed under the Endangered Species Act: Pacific Northwest. NOAA Technical Memorandum NMFS-NWFSC-113:281 pp.

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.

Gilbreath, L. G., D. A. Smith, R. D. Ledgerwood, S. S. Pool, and S. J. Grabowski. 2000. Limnological Investigations in John Day Reservoir Including Selected Upper Reservoir Habitats, April 1994 to September 1995. Northwest Fisheries Science Center. Report to the U.S. Army Corps of Engineers. October 2000.

Good, T. P., R. S. Waples, and P. Adams. 2005. Updated status of federally listed ESUs of West Coast Salmon and Steelhead. NOAA Technical Memorandum. NMFS-NWFSC 66:598 pp.

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.

Halvorsen, M. B., B. M. Casper, C. M. Woodley, T. J. Carlson, and A. N. Popper. 2012. Threshold for onset of injury in Chinook salmon from exposure to impulsive pile driving sounds. PLOS ONE, 7(6), e38968.

Hanson, J., M. Helvey, and R. Strach (editors). 2003. Non-Fishing Impacts to Essential Fish Habitat and Recommended Conservation Measures. National Marine Fisheries Service.

Harnish, R. A., E. D. Green, K. A. Deters, K. D. Ham, Z. Deng, H. Li, B. Rayamajhi, K. W. Jung, and G. A. McMichael. 2014. Survival of Wild Hanford Reach and Priest Hatcheries Fall Chinook Salmon Juveniles in the Columbia River: Predation Implications. PNNL-23719. Battelle Pacific Northwest National Laboratory prepared for the Pacific Salmon Commission under U.S. Department of Energy contract #DE-AC05-76RL01830. Richland, Washington. October.

Hastings, M. C., and A. N. Popper. 2005. Effects of Sound on Fish. Report prepared for Jones and Stokes and to California Department of Transportation. Sacramento, California.

Hecht, S. A., D. H. Baldwin, C. A. Mebane, T. Hawkes, S. J. Cross., and N. L. Scholtz. 2007. An Overview of Sensory effects on juvenile salmonids exposure to dissolved copper; applying a benchmark concentration approach to evaluate sublethal neurobehavioral toxicity. U.S. Department of Commercial. NOAA Tech Memo. NMFS-NMFS-NWFSC-83.

Herrera Environmental Consultants. 2006. Technology Evaluation and Engineering Report: Ecology Embankment. Washington State Department of Transportation. Olympia.

Hirschman, D., K. Collins, and T. Schueler. 2008. Technical Memorandum: The Runoff Reduction Method. Center for Watershed Protection. Ellicott City, Maryland. April 18. https://dep.wv.gov/WWE/Programs/stormwater/MS4/permits/Documents/Runoff%20Reduction%20technical%20memo%202008.pdf

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. 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.

ICTRT. 2010. Current status reviews: Interior Columbia basin ESUs and DPS. Vol 1. Snake River Basin ESUs/DPSs. Interior Columbia Review Team. 812p + Appendices.

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

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 (editors)]. IPCC, Geneva, Switzerland.

ISAB (Independent Scientific Advisory Board), editor. 2007. Climate change impacts on Columbia River Basin fish and wildlife, volume ISAB 2007-2. Independent Scientific Advisory Board, Northwest Power and Conservation Council, Portland, Oregon.

Kayhanian, M., A. Singh, C. Suverkropp, and S. Borroum. 2003. Impact of annual average daily traffic on highway runoff pollutant concentrations. Journal of Environmental Engineering 129:975–990.

Keefer, M. L., C. T. Boggs, C. A. Peery, and C. C. Caudill. 2008a. Overwintering Distribution, Behavior, and Survival of Adult Summer Steelhead: Variability among Columbia River Populations. North American Journal of Fisheries Management 28:81–96.

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

Liberman, M. C. 2016. Noise-induced hearing loss: Permanent versus temporary threshold shifts and the effects of hair cell versus neuronal degeneration. *In* A. N. Popper & A. D. Hawkins (editors), The Effects of Noise on Aquatic Life II (pp. 1–7). New York: Springer.

Lindsey, R., and L. Dahlman. 2020. Climate Change: Global Temperature. Available at: https://www.climate.gov/news-features/understanding-climate/climate-change-global-temperature

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.

Loge, F., M. R. Arkoosh, T. R. Ginn, L. L. Johnson, and T. K. Collier. 2006. Impact of environmental stressors on the dynamics of disease transmission. Environmental Science & Technology 39(18):7329–7336.

MacFarlane, R. B., and E. C. Norton. 2002. Physiological ecology of juvenile Chinook salmon (*Oncorhynchus tshawytscha*) at the southern end of their distribution, the San Francisco Estuary and Gulf of the Farallones, California. Fishery Bulletin 100(2):244–257.

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, Seattle, 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.

Martins, E. G., S. G. Hinch, D. A. Patterson, M. J. Hague, S. J. Cooke, K. M. Miller, D. Robichaud, K. K. English, and A. P. Farrell. 2012. High river temperature reduces survival of sockeye salmon (*Oncorhynchus nerka*) approaching spawning grounds and exacerbates female mortality. Canadian Journal of Fisheries and Aquatic Sciences 69(2):330–342.

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

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 Commerce, editor. 156 pp.

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.

Melillo, J., T. Richmond, and G. Yohe. 2014. Climate Change Impacts in the United States: The Third National Climate Assessment, Washington, D.C.

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. DOI:10.7930/J04Q7RWX.

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.

Mullan, J. W., K. R. Williams, G. Rhodus, T. W. Hillman, and J. D. McIntyre. 1992. Production and habitat of salmonids in Mid-Columbia River tributary streams. U.S. Fish and Wildlife Service.

NCHRP (National Cooperative Highway Research Program). 2006. Evaluation of Best Management Practices for Highway Runoff Control. Transportation Research Board. NCHRP Report 565. Washington, D.C. https://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_565.pdf

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

NMFS (National Marine Fisheries Service). 2005. Final assessment of NMFS' critical habitat analytical review teams 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. 2009. Middle Columbia River Steelhead Distinct Population Segment ESA Recovery Plan. National Marine Fisheries Service, Northwest Region.

NMFS. 2011a. 5-year review: Summary and evaluation of Snake River sockeye, Snake River Spring-Summer Chinook, Snake River Fall-run Chinook, Snake River Basin steelhead.

NMFS. 2011b. Draft recovery plan for Idaho Snake River spring/summer Chinook and steelhead populations in the Snake River spring/summer Chinook salmon evolutionarily significant unit and Snake River steelhead distinct population segment. National Marine Fisheries Service, editor, Portland, Oregon.

NMFS. 2013. ESA recovery plan for Lower Columbia River coho salmon, Lower Columbia River Chinook salmon, Columbia River chum salmon, and Lower Columbia River steelhead.

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.

NMFS. 2020. Endangered Species Act (ESA) Section 7(a)(2) Biological Opinion and Magnuson–Stevens Fishery Conservation and Management Act Essential Fish Habitat Response, continued operation and maintenance of the Columbia River System. NMFS Consultation Number: WCRO-2020-00113.

NOAA Fisheries. 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.

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

ODEQ (Oregon Department of Environmental Quality). 2020. Oregon's 2018/2020 Integrated Report Assessment Database and 303(d) List. Portland, Oregon. Available at: https://www.oregon.gov/deq/wq/Pages/epaApprovedIR.aspx

Petersen, J. H., and D. M. Gadomski. 1994. Light-mediated predation by northern squawfish on juvenile Chinook salmon. National Biological Survey, Pacific Northwest Natural Science Center, Columbia Research laboratory. Journal of Fish Biology 45: 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.

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.

Poe, T. P., H. C. Hansel, S. Vigg, D. E. Palmer, and L. A. Predergast. 1991. Feeding of predaceous fishes on out-migrating juvenile salmonids in John Day Reservoir, Columbia River. Transactions of the American Fisheries Society 120:405–420.

Popper, A. N., T. J. Carlson, A. D. Hawkins, B. L. Southall, and R.L. Gentry. 2006. Interim Criteria for Injury of Fish Exposed to Pile-driving Operations: A White Paper. Submitted to the Fisheries Hydroacoustic Working Group. 15 pp.

Popper A. N., A. D. Hawkins, and M. B. Halvorsen. 2019. Anthropogenic Sound and Fishes. Washington State Department of Transportation. Olympia.

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. Island Press:41–58.

Rieman, B. E., R. C. Beasesderfer, S. Vigg, and T. P. Poe. 1991. Estimating loss of juvenile salmonids in predation by northern squawfish, walleyes, and smallmouth bass on John Day Reservoir, Columbia River. Transactions of the American Fisheries Society 120 (4):448–458.

Rodkin, R., and K. Pommerenck, 2014. Caltrans compendium of underwater sound date from pile driving – 2014 update. Inter-noise 2014. Melbourne, Australia. November.

Rogers, P. H., and M. Cox. 1988. Underwater sound as a biological stimulus. p. 131–149 *In:* J. Atema, R. R. Fay, A. N. Popper, and W. N. Tavolga (editors). Sensory biology of aquatic animals. Springer–Verlag, New York.

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.

Sandahl, J. P., D. H. Baldwin, J. J. Jenkins, and N. L. Scholz. 2007. A sensory system at the interface between urban stormwater runoff and salmon survival. Environmental Science & Technology 41(8):2998–3004.

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: 1389–1395.

Sigler, J. W., T. Bjornn, and F. Everest. 1984. Effects of chronic turbidity on density and growth of steelhead and Coho salmon. Transactions of the American Fisheries Society 113:142–150.

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.

Spromberg, J. A., and J. P. Meador. 2006. Relating chronic toxicity responses to population-level effects: A comparison of population-level parameters for three salmon species as a function of low-level toxicity. Ecological Modeling 199:240–252.

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.

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. U.S. Fish and Wildlife Service, Lacey, Washington.

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. NMFS, USFWS and Upper Columbia Salmon Recovery Board.

USGCRB (U.S. Global Change Research Program). 2018. Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II: [Reidmiller, D. R., C. W. Avery, D. R. Easterling, K. E. Kunkel, K.L.M. Lewis, T. K. Maycock, and B. C. Stewart (editors)]. U.S. Global Change Research Program, Washington, D.C., USA, 1515 pp. doi:10.7930/NCA4.2018

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.

WSDOT (Washington State Department of Transportation). 2016. Pile Diameter & Noise Levels. September 2016.

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.

Werner, K., R. Zabel, D. Huff, and B. Burle. 2017. Ocean conditions and salmon returns for 2017–2018. Memorandum to M. Tehan (NMFS), West Coast region. Northwest Fisheries Science Center, Seattle, 8/18/2017.

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.

Wursig, B., C. R. Greene, and T. A. Jefferson. 2000. Development of an Air Bubble Curtain to Reduce Underwater Noise from Percussive Piling. Marine Environmental Research. 49:19–93.

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.

Zabel, R. W., D. D. Huff, and B. J. Burke. 2020. Ocean conditions and salmon returns for 2019. Memorandum to M. Tehan, NMFS West Coast Region. Northwest Fisheries Science Center Seattle, 1/30/2020.

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.