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-2022-02224

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September 26, 2022

Michael S. Erickson
Chief, Environmental Compliance Section
U.S. Army Corp of Engineers, Walla Walla District
201 North 3rd Avenue
Walla Walla, WA 99362

Re: Endangered Species Act Section 7(a)(2) Biological Opinion and Magnuson–Stevens Fishery Conservation and Management Act Essential Fish Habitat Response for the Snake River Channel Maintenance 2022/2023 Project

Dear Mr. Erickson:

Thank you for your letter we received on April 26, 2022 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 Snake River Channel Maintenance 2022/2023 Project.

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.

On July 5, 2022, the U.S. District Court for the Northern District of California issued an order vacating the 2019 regulations that were revised or added to 50 CFR part 402 in 2019 ("2019 Regulations," see 84 FR 44976, August 27, 2019) without making a finding on the merits. On September 21, 2022, the U.S. Court of Appeals for the Ninth Circuit granted a temporary stay of the district court's July 5 order. As a result, the 2019 regulations are once again in effect, and we are applying the 2019 regulations here. For purposes of this consultation, we considered whether the substantive analysis and conclusions articulated in the biological opinion and incidental take statement would be any different under the pre-2019 regulations. We have determined that our analysis and conclusions would not be any different.

In this Biological Opinion (opinion), NMFS concludes that the action, as proposed, is not likely to jeopardize the continued existence of Snake River spring/summer Chinook salmon (*Oncorhynchus tshawytscha),* Snake River Fall Chinook salmon (*O. tshawytscha*), Snake River Basin steelhead (O. mykiss), and Snake River sockeye salmon (*O. nerka*). NMFS also determined the action will not destroy or adversely modify designated critical habitat for Snake

River spring/summer Chinook salmon, Snake River fall Chinook salmon, Snake River Basin steelhead, and Snake River sockeye salmon. Rationale for our conclusions is provided in the attached opinion.

As required by section 7 of the ESA, NMFS provides an incidental take statement (ITS) with the opinion. The ITS describes reasonable and prudent measures (RPM) NMFS considers necessary or appropriate to minimize the impact of incidental take associated with this action. The take statement sets forth terms and conditions, including reporting requirements that the U.S. Army Corps of Engineers (Corps) and their contractors must comply with in order to be exempt from the ESA take prohibition.

This document also includes the results of our analysis of the action's effects on EFH pursuant to section 305(b) of the MSA, and includes one Conservation Recommendation to avoid, minimize, or otherwise offset potential adverse effects on EFH. This Conservation Recommendation is similar, but not identical to the ESA terms and conditions. Section 305(b)(4)(B) of the MSA requires Federal agencies to provide a detailed written response to NMFS within 30 days after receiving these recommendations. If the response is inconsistent with the EFH Conservation Recommendation, the Corps must explain why the recommendation will not be followed, including the justification for any disagreements over the effects of the action and the recommendation. In response to increased oversight of overall EFH program effectiveness by the Office of Management and Budget, NMFS established a quarterly reporting requirement to determine how many Conservation Recommendations are provided as part of each EFH consultation and how many are adopted by the action agency. Therefore, in your statutory reply to the EFH portion of this consultation, NMFS asks that you clearly identify whether you accept this Conservation Recommendation.

Please contact Jim Mital, Moscow Field Office at 208-310-0663 or jim.mital@noaa.gov, if you have any questions concerning this consultation or if you require additional information.

Sincerely,

Michael P. Tehan
Assistant Regional Administrator for
Interior Columbia Basin Office

Enclosure

cc: Ben Tice, Corps
Kat Sarensen, USFWS
Jay Hesse, NPT
Gary James, CTUIR
Marika Dobos, IDFG

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

Snake River Channel Maintenance 2022/2023

NMFS Consultation Number: WCRO-2022-02224

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

Affected Species and NMFS' Determinations:

ESA-Listed Species	Status	Is Action Likely to Adversely Affect Species?	Is Action Likely to Jeopardize the Species?	Is Action Likely to Adversely Affect Critical Habitat?	Is Action Likely to Destroy or Adversely Modify Critical Habitat?
Snake River spring/summer Chinook salmon (*Oncorhynchus 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 Basin steelhead (*O. mykiss*)	Threatened	Yes	No	Yes	No

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

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

Issued By:

Michael P. Tehan
Assistant Regional Administrator for Interior Columbia Basin Office
West Coast Region
National Marine Fisheries Service

Date: September 26, 2022

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ACRONYMS

BA	Biological Assessment
CFR	Code of Federal Regulations
cfs	Cubic feet per second
Corps	U.S. Army Corps of Engineers
cy	Cubic yard
DART	Data Access in Real Time
DEP	Deepwater Electroshocking Platform
DMMU	Dredge Material Management Unit
DOC	Dissolved Organic Carbon
DPS	Distinct Population Segment
DQA	Data Quality Act
DW	Dry Weight
EFH	Essential Fish Habitat
EPA	Environmental Protection Agency
ESA	Endangered Species Act
ESU	Evolutionarily Significant Unit
FMP	Fishery Management Plan
FR	Federal Register
HAPC	Habitat Area of Particular Concern
IC	Inhibition Concentration
ICTRT	Interior Columbia Technical Recovery Team
IDEQ	Idaho Department of Environmental Quality
ISAB	Independent Scientific Advisory Board
ITS	Incidental Take Statement
LC	Lethal Concentration
LGD	Lower Granite Dam
LGR	Lower Granite Reservoir
MOP	Minimum Operating Pool
MPG	Major Population Group
MSA	Magnuson–Stevens Fishery Conservation and Management Act
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
NOEC	No Observed Effect Concentration
NPT	Nez Perce Tribe
NTU	Nephelometric Turbidity Unit
Opinion	Biological Opinion
PAH	Polycylcic Aromatic Hydrocarbon
PBDE	Polybrominated diphenyl
PBF	Physical or Biological Feature
PBT	Persistent Bio-accumulating Toxicants
PCB	Polychlorinated Biphenyl
PCE	Primary Constituent Element
PEL	Probable Effects Level

PNNL	Pacific Northwest National Laboratory
POP	Persistent Organochlorine Pollutant
PSMP	Programmatic Sediment Management Plan
RM	River Mile
RPA	Reasonable and Prudent Alternative
RPM	Reasonable and Prudent Measure
SEF	Sediment Evaluation Framework for the Pacific Northwest
SEV	Severity of ill effects score
SRB	Snake River Basin (steelhead)
SMS	Sediment Management Standards
SRF	Snake River fall-run (Chinook)
SRSS	Snake River spring/summer-run (Chinook)
TEC	Threshold Effect Concentrations
USACE	U.S Army Corps of Engineers
U.S.C.	U.S. Code
USFWS	U.S. Fish and Wildlife Service
USGCRP	U.S. Global Change Research Program
WDOE	Washington Department of Ecology
WW	Wet Weight
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

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

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 NMFS Northern Snake Branch office in Boise, Idaho.

1.2. Consultation History

On April 26, 2022, NMFS received a biological assessment (BA) and a request for ESA and MSA consultations from the U.S. Army Corps of Engineers (Corps) for dredging at five locations in the Snake and Clearwater Rivers and depositing the dredged material in the water (USACE 2022).

Additional details regarding the proposed action were also received by NMFS from the Corps on various dates in 2022. The consultation chronology is:

- The Corps introduced the project to NMFS and the U.S. Fish and Wildlife Service (USFWS) on March 31, 2022.
- NMFS received the Biological Assessment on April 26, 2022.
- NMFS received the 2019 sediment sampling documentation from the Corps on May 24, 2022.
- NMFS received an email on June 29, 2022 from the Corps stating that the proposed action had not changed due to concerns from USFWS and the Nez Perce Tribe (NPT) regarding Pacific lamprey and freshwater mussels.
- NMFS received an email on August 26, 2022 from the Corps with changes to the proposed action related to monitoring of Pacific lamprey and freshwater mussels.

This paragraph documents key points of the prior dredging and related consultations for NMFS-listed species. The Corps previous dredging actions have required three ESA section 7 formal consultations since 2001 (NWR-2001-301; NWR-2003-01293, WCR-2014-01723). After challenges to these section 7consultations, the parties reached a settlement in 2005 that permitted the Corps to perform a limited, one-time maintenance dredge and fill in 2005/2006 but with the condition that the Corps complete a review under National Environmental Policy Act (NEPA) on the long-term management of sediment in the lower Snake River. In response to the 2005 settlement, in 2014 the Corps developed a Programmatic Sediment Management Plan (PSMP) for the lower Snake River and Environmental Impact Statement for the PSMP. The Corps consulted with NMFS on the PSMP in 2014 (WCR-2014-1704). Also, in 2014, NMFS completed a new consultation on maintenance dredging of the lower Snake and Clearwater Rivers (WCR-2014-1723) and maintenance dredging was conducted in 2015.

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 (see 50 CFR 402.02). Under the MSA, "Federal action" means any action authorized, funded, or undertaken, or proposed to be authorized, funded, or undertaken by a Federal agency (see 50 CFR 600.910).

The Federal navigation channel in the Snake River refers to that portion of the Snake River inland navigation waterway maintained by the Corps. The navigation waterway begins at the Columbia and Snake Rivers confluence and extends upstream past four dams to the head of the Lower Granite reservoir (Figure 1).

The Corps maintains a 14-foot-deep (plus 2-foot overdredge), 250-foot-wide navigation channel (at minimum operating pool (MOP)) through these reservoirs. The proposed action consists of dredging of the following sites: (1) Downstream navigation lock of Ice Harbor Dam (Snake River river mile (RM) 9.5); (2) the Federal navigation channel in the Snake and Clearwater Rivers confluence area (Snake RM 138 to RM 139.5; Clearwater RM 0 to RM 2) 2); (3) berthing areas for the Port of Clarkston, Washington (Snake River RM 137 and 139); (4) the Port of Clarkston access channel (between the Port of Clarkston docks and the Federal navigation channel); and (5) the berthing area for the Port of Lewiston, Idaho (Clearwater River RM 1 to 1.5). Dredged materials will be deposited at Bishop Bar (Snake River RM 118) within the Lower Granite reservoir.

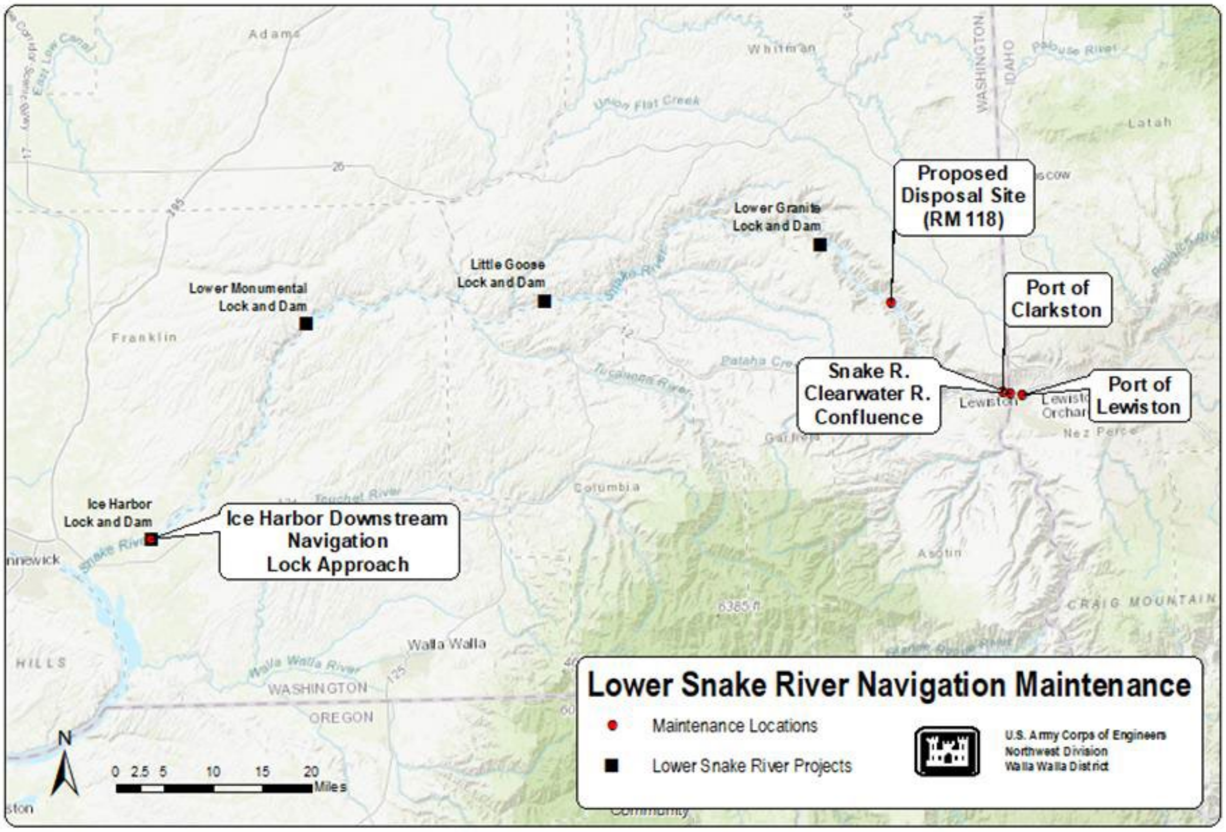

Figure 1. The Federal navigation channel in the lower Snake River from the confluence with the Columbia River to the confluence with the Clearwater River at Clarkston, Washington. (USACE 2022).

Sedimentation at the downriver approaches to the navigation locks is an ongoing problem for navigation. Congress has authorized the Corps to provide navigation facilities, including locks to allow passage of a tug towing four barges, at each of the four lower Snake River dams. Accumulated cobble and gravel presently complicate boat passage into the Ice Harbor navigation lock. The Corps proposes to remove this material to restore passage to authorized dimensions. The quantity of material to be removed, by location, is shown in Table 1.

Table 1. Sites proposed for immediate maintenance dredging (USACE 2022).

Site to be Dredged	**Quantity to be Dredged (cy)[1]**
Federal navigation channel at confluence of Snake and Clearwater Rivers (Snake RM 138 to Clearwater RM 2)	162,040
Port of Clarkston (Snake RM 137 and 139)	21,600
Port of Clarkston Access Channels	67,740
Port of Lewiston (Clearwater RM 1-1.5)	4,380
Ice Harbor Navigation Lock Approach (Snake RM 9.5)	2,150
Total	**257,910**

1 Based on removal to 16 ft below MOP using survey data from 2021.

The purpose of the routine channel maintenance is to provide a 14-foot depth throughout the designated Federal navigation channel in the project area and to restore access to selected port berthing areas. Sediment deposition can affect uses of the lower Snake River by building up on the existing bottom, thus reducing the water depth. Sediment deposits that create shallow-water areas are called shoals. Because routine channel maintenance has not occurred since 2014/2015, shoaling in the channel has become critical in some locations. There is a safety hazard if the water depth over the shoal is less than that shown on navigation charts, as vessels striking the shoal may become grounded and be damaged.

Confluence of Snake and Clearwater Rivers (Federal Navigation Channel). The Corps will remove approximately 162,040 cubic yards (cy) of material from the Federal navigation channel at the confluence of the Snake and Clearwater Rivers (Figure 2). Sediment samples were collected in September and October of 2019 from the main navigation channel in the confluence area. In general, the grain size was higher in the Clearwater River dredge material management units (DMMUs) relative to the DMMUs below the confluence in the Snake River. The average percent sand and fines (i.e., small particles of sediment, generally silts and clays) from the 2019 samples was 96 percent and 4 percent, respectively.

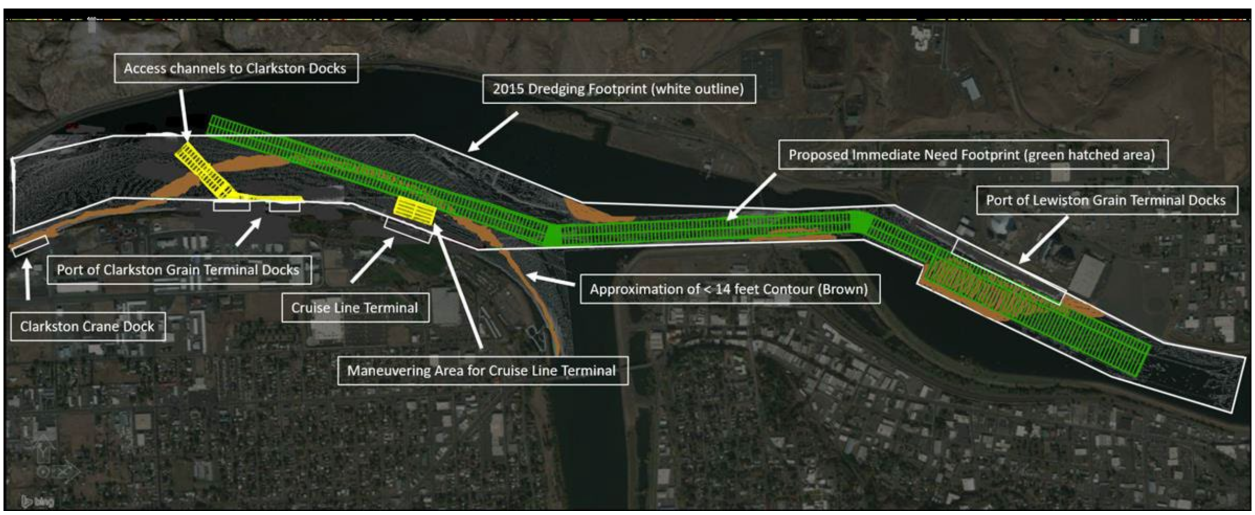

Figure 2. Federal Navigation Channel near Clarkston, WA and Lewiston, ID. Navigation channel is in green. Access channels are in yellow, and the shallow-water areas are in orange (USACE 2022).

Port of Clarkston. Approximately 21,600 cy of material will be removed from four berthing areas at the Port of Clarkston, the crane dock at the downstream end of the Port property, the grain dock, the recreation dock, and the cruise boat dock at the upstream end (Figure 3). The berthing area is defined as a zone extending approximately 50 feet out into the river from the port facilities and running the length of the port facilities. Maintenance in this area is the port's responsibility, and the Port of Clarkston will provide funding to the Corps for this portion of the work. This area was last dredged in 2015. Sediment surveys in 2019 showed that sediment composition was primarily of 64- to 93-percent sand and 7- to 36-percent fines.

Figure 3. Port of Clarkston dredging areas (USACE 2022).

Port of Clarkston Access Channels. Due to the reduced Federal navigation channel footprint, two access channels (yellow areas in Figure 2) need to be dredged to connect the navigation channel to the Port of Clarkston's docks. Approximately 67,740 cy of material will be removed from the access channels.

Port of Lewiston. Approximately 4,380 cy of material will be removed from the berthing area at the Port of Lewiston (Figure 4). The berthing area is defined as a zone extending approximately 50 feet out into the river from the port facilities and running the length of the port facilities. Maintenance in this area is the port's responsibility, and the Port of Lewiston will provide funding to the Corps for this portion of the work. The area was last dredged in 2014/2015. Sediment surveys in 2019 showed that sediment composition was 97 percent sand and 3 percent fines.

Figure 4. Port of Lewiston dredging area (USACE 2022).

Ice Harbor Lock Approach. About 2,150 cy of material will be removed from the Ice Harbor lock approach (Figures 5 and 6). This quantity is for dredging to a depth of 16 feet below MOP (14-foot dredge plus 2 feet of overdredge). Dredging last occurred in this area in 2015. Sediment sampling in 2011 showed that sediment composition was rock substrate and cobbles greater than or equal to 2-6 inches.

Figure 5 . Port of Lewiston dredging area (USACE 2022).

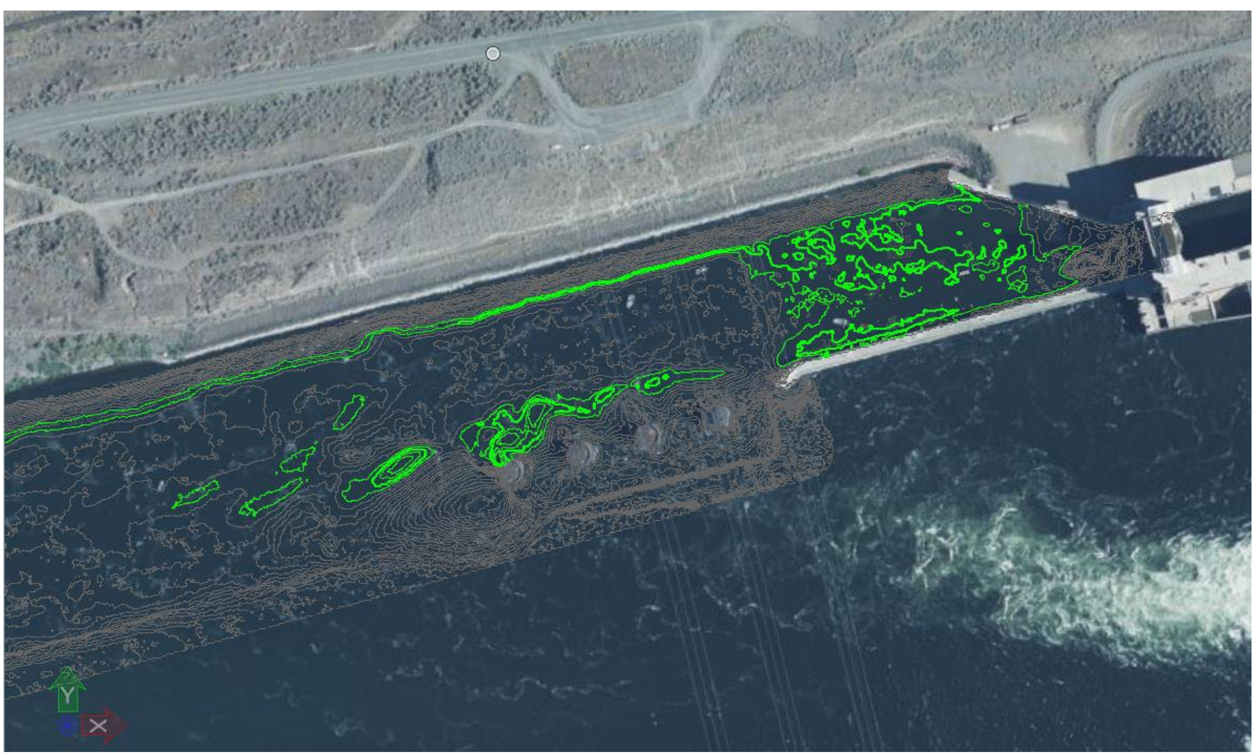

Figure 6. Figure 6. Shoaling at Ice Harbor navigation lock approach. Areas less than 16 feet deep at MOP are in green (USACE 2022).

Disposal Site. The Corps identified a location in the Lower Granite reservoir near Bishop Bar, RM 118 (Figures 1 and 7), as the proposed in-water discharge site of the dredged materials. The site is located outside of the Federal navigation channel, and experiences lower velocities than the main thalweg.

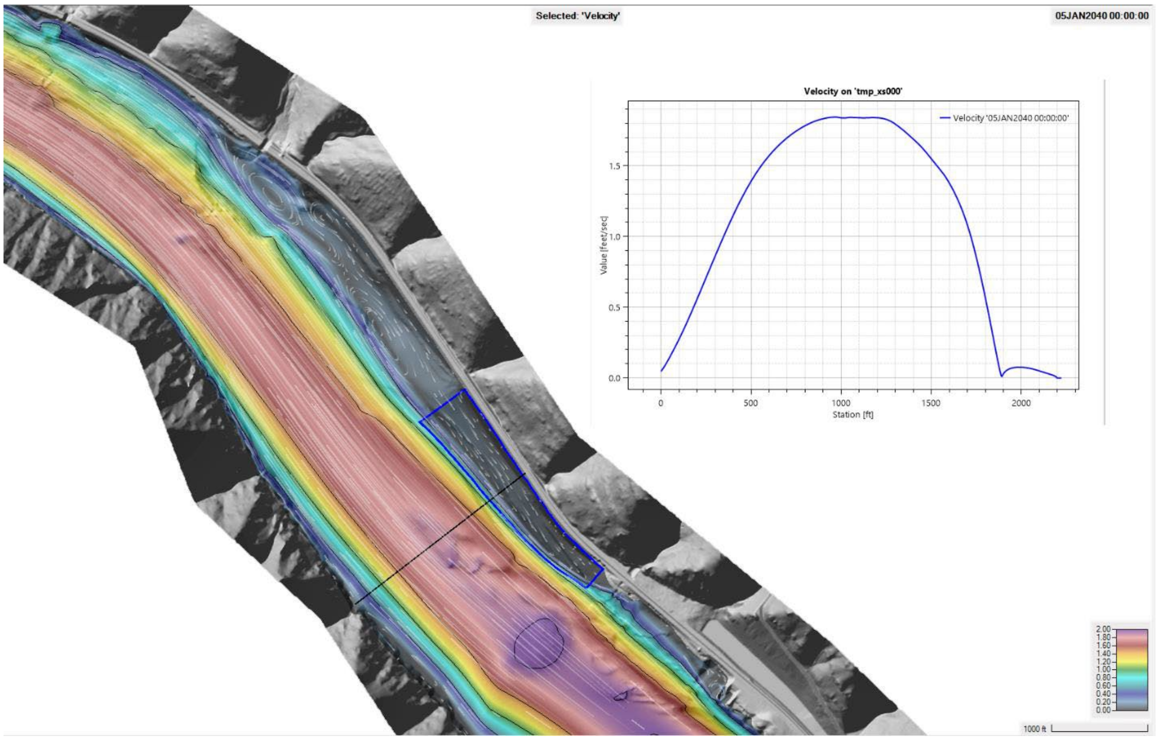

Figure 7. Velocity vector map of the proposed RM 118 disposal site at Bishop Bar (USACE 2022). The disposal area is shown with a thin blue outline in middle of the figure along right bank side of the river channel.

The material at the Ice Harbor navigation lock approach may be removed first. It would be placed on the bottom of the disposal area then the equipment will move up to the Clarkston/Lewiston sites. Once the barge is full, a tugboat will push it to the disposal site. No material or water will be discharged from the barge while in transit. For in-water disposal, when the barge arrives at the disposal site and is properly positioned, the bottom will be opened to dump the material all at once. Once unloaded, the barge will be returned to the dredging site for additional loads. The DMMP agencies have concluded that all 36,000 cy of proposed dredge material from the Port of Clarkston and Port of Lewiston DMMUs are suitable for open-water disposal at the proposed Lower Granite site. Material from the Ice Harbor Lock Approach is considered suitable regardless of volume, due to the cobbly nature of the material.

The new disposal site runs approximately 1,700 feet along the shoreline and covers approximately 23 acres. Dredged material will be deposited at the downstream end first and then progress upstream. At the disposal site, the dredged material will be placed in steps. The first step will be to place the cobbles from the Ice Harbor navigation lock approach along the outer edge of the planned footprint. This will be followed by placing a mixture of the silt and sand to fill the mid-depth portion of a site and form a base embankment.

The dredged material will be transported by barge to the disposal area, where the material will be placed within the designated footprint. This footprint will be close to the shoreline, so that the river bottom could be raised to create an underwater shelf about 20 ft below MOP.
The disposal area will be sloped at 10% towards the middle of the river with the top of the disposal area being at least 20 feet below MOP (Figure 8). Due to the lower quantity of dredged material compared to the 2015 dredging, there is not enough material to create shallow water habitat at this time. If there is a need for future dredging efforts, this 2022/2023 disposal site could be augmented to create shallow water habitat for rearing salmonids.

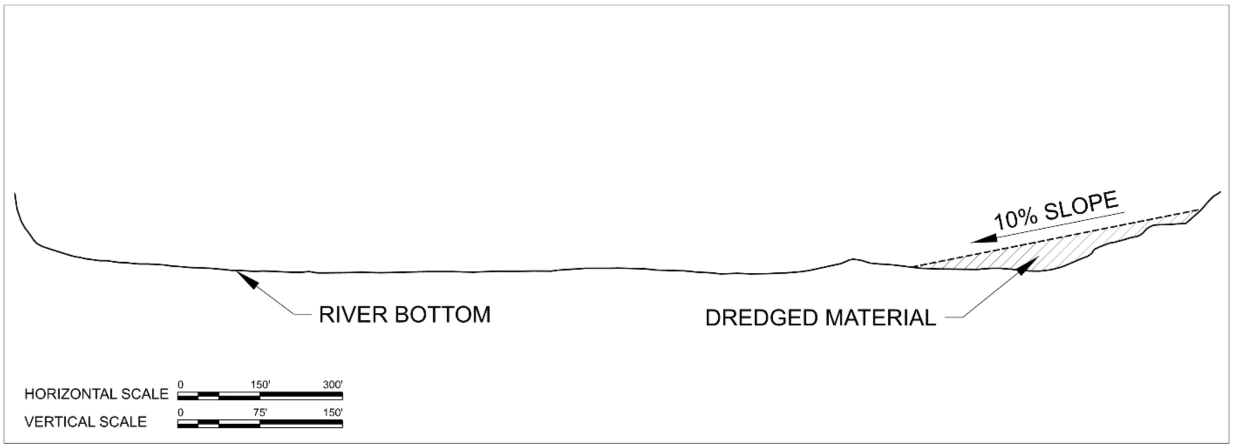

Figure 8. Cross section of disposal site at Bishop Bar RM 118 (USACE 2022).

Sediment Removal Methods. Dredging will be accomplished by a contractor using mechanical methods, such as a clamshell, dragline, or shovel/scoop. Material will be dredged from the river bottom and loaded onto barges for transport to the Bishop Bar disposal site (Figure 7). Clamshell dredges with a capacity of approximately 15 cy and barges with capacity of up to 3,000 cy and maximum drafts of 14 feet will be used. Sediment will be removed to a depth of up to 16 feet below MOP. This is consistent with the Corps' policy of funding one foot of "overdepth" to account for inaccuracies in mechanical dredging methods and one foot of advance dredging to reduce the frequency of dredging. It will take about 6 to 8 hours to fill a barge. The expected rate of dredging is 3,000 to 5,000 cy per 8-hour shift. The contractor could be expected to work up to 24 hours per day and 7 days per week if needed.

Material will be scooped from the river bottom and loaded onto a barge, most likely a bottom-dump barge. While the barge is being loaded, the contractor will be allowed to overspill excess water from the barge, to be discharged a minimum of 2 feet below the river surface.

Monitoring. Based on monitoring during the 2015 dredging project, turbidity is likely the main habitat parameter influenced by the proposed action. The Corps proposes to monitor water quality, biological effects, and structural stability of the disposed material associated with the navigation channel maintenance dredging at five locations in the lower Snake River and lower Clearwater River in Washington and Idaho. This plan includes water quality monitoring that has been historically required for maintenance dredging projects in the lower Snake River as well as addressing concerns raised in previous ESA consultations. These concerns include stability of the disposal embankment.

Additional monitoring requirements may be identified in the Section 401 Water Quality Certification the Corps is requesting from Ecology and from Idaho Department of Environmental Quality. The Corps intends to issue one or more reports presenting the results of the monitoring. All the Corps' monitoring activities described in this plan may be conducted either by the Corps or its contractors, based on the availability of funds. Monitoring will be conducted pre-dredging, during dredging and disposal, and post-dredging and disposal.

Pre-dredging monitoring includes redd surveys within the Ice Harbor navigation lock approach. Based on multiple years of surveys since 1993, no redds have ever been found within the navigation lock approaches of any of the lower Snake River dams (Mueller and Coleman 2007, Mueller and Coleman 2008). Since potential spawning habitat exists within the footprint of the proposed dredging area of the Ice Harbor Dam tailrace, the proposed action may have the potential to disturb or harm eggs and alevins in redds if found to be present immediately prior to or during the proposed dredging activities.

In an effort to avoid disturbing or harming fall Chinook redds, the Corps will conduct underwater surveys of the proposed dredging site at the Ice Harbor navigation lock in November and the first 2 weeks of December in 2022 prior to dredging. A boat-mounted underwater video camera tracking system will be used to look at the bottom of the river to identify redds. Results of the surveys will be transferred to the Corps within 2 days of the survey dates in order for compilation prior to December 15, at which time the Corps will communicate results to NMFS for appropriate action. (The Corps stated that they will also report these redd survey results to the Nez Perce Tribe prior to dredging at this location.) If no redds are located, then the Corps will proceed with proposed dredging within the boundaries of the surveyed template. If one or more redds are located within the proposed dredging template and such redds are verified with video, then the Corps will coordinate with NMFS to determine what the appropriate avoidance and protection actions should be prior to dredging the affected location.

During the dredging and disposal activities, the Corps will monitor water quality to ensure state criteria are not being exceeded. Water quality turbidity monitoring will be performed before, during, and after all in-river work at each active dredging site and at the disposal site (Figure 9). The background reference monitoring station will be 300-feet upstream from the dredging location, the early warning station will be 300-feet downstream from the dredging location, and the compliance station will be 900-feet downstream from the dredging location. The equipment will have the capability to transmit the data via satellite or radio relay rather than having to be downloaded at each station in the field. Water quality monitoring will take place upstream (for background) and downstream of the dredge (for project impacts). The data will be collected near real-time so that timely measures can be taken to avoid exceeding both Washington and Idaho state water quality standards. If water quality standards are exceeded, the contractor will modify operations to reduce turbidity to levels within state standards.

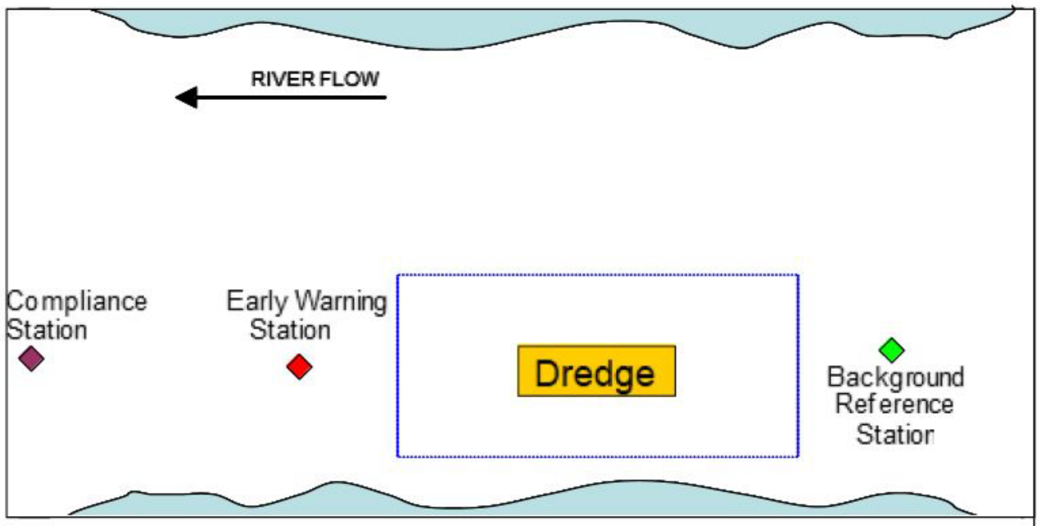

Figure 9. Conceptual schematic of water quality monitoring locations during dredging activities (USACE 2022).

The Corps' contractor will monitor for sick, injured, or dead fish. They will visually monitor the waters surrounding the dredging and disposal activities as well as observing the content of each clamshell bucket as it discharges in the barges. If a sick, injured, or dead specimen is encountered, it will be placed in a container of cold river water until it could be determined if it is an ESA-listed species. If it is a listed species, the contractor will notify the Corps and the Corps will then contact the appropriate regulatory agency as soon as possible for further instructions. If a healthy fish gets entrained by the dredging operations, the Corps will make every reasonable attempt to return the specimen safely back to the river.

Post-dredging and disposal will include hydrographic surveys to ensure the disposal site is constructed as planned. The Corps will perform follow up surveys after the first spring runoff following disposal. Monitoring embankment stability will be accomplished by taking soundings soon after disposal is complete. Soundings will again be taken in the summer after high flows in order to determine if the embankment slumped or moved.

The Corps proposes to monitor for the presence of larval Pacific Lamprey (*Entosphenus tridentatus*) in areas to be dredged using a deepwater electroshocking platform (DEP) near the confluence of the Snake and Clearwater rivers near Clarkston, WA in the fall of 2022 (Appendix A). Incidental observations of freshwater mussels will also be recorded. The Corps would like to determine the potential for larval Pacific lamprey and freshwater mussels to be rearing in areas to be dredged. Adult lamprey translocations have been occurring for several years and existing lamprey data may not reflect the results of these translocation efforts.

The DEP system consists of a weighted diving sled coupled with a shocking system, optical camera, recording system and paired red lasers (class 3, 5 mW) for scaling and measurements. The DEP was designed to shock and film a riverbed area of approximately 0.5 m^2 during ideal conditions. Two high-resolution monitors for real-time viewing of the video are employed in conjunction with the recorder. Monitoring will occur during the dredging in-water work window as described in Appendix A of this opinion.

Project Schedule. The Corps proposes to perform maintenance dredging in the 2022/2023 winter in-water work window (December 15, 2022 - March 1, 2023) to meet the immediate need of providing a 14-foot water depth as measured at MOP at five locations in the lower Snake River and lower Clearwater River. This in-water work window was established through coordination with state and Federal resource agencies as the time period in which work could be performed with the least impact to ESA-listed salmonid stocks.

We considered, under the ESA, whether or not the proposed action would cause any other activities and determined that it would cause the following activities: the continued use of barges in the action area would not continue but for the proposed 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.

The Corps has determined the proposed action is likely to adversely affect Snake River spring/summer (SRSS) Chinook salmon (*Oncorhynchus tshawytscha),* Snake River (SR) fall Chinook salmon (*O. tshawytscha*), Snake River Basin (SRB) steelhead (*O. mykiss*), and SR sockeye salmon (*O. nerka*), and their designated critical habitat.

2.1. Analytical Approach

This opinion includes both a jeopardy analysis and an adverse modification analysis. The jeopardy analysis relies upon the regulatory definition of "jeopardize the continued existence of" a listed species, which is "to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species" (50 CFR 402.02). Therefore, the jeopardy analysis considers both survival and recovery of the species.

This biological opinion also relies on the regulatory 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 the four listed species considered in this opinion use the term primary constituent element (PCE) or essential features. The 2016 final rule (81 FR 7414;

February 11, 2016) that revised the 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 ESA Section 7 implementing regulations define effects of the action using the term "consequences" (50 CFR 402.02). As explained in the preamble to the final rule revising the definition and adding this term (84 FR 44976, 44977; August 27, 2019), that revision 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 critical 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 (RPA) 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" for the jeopardy analysis. The opinion also examines the condition of critical habitat throughout the designated area, evaluates the conservation value of the various watersheds that make up the designated area, and discusses the function of the PBFs that are essential for the conservation of the species. The Federal Register (FR) notices and notice dates for the species and critical habitat listings considered in this opinion are included in Table 2.

Table 2. Listing status, status of critical habitat designations and protective regulations, and relevant Federal Register decision notices for ESA-listed species considered in this opinion.

Species	Listing Status	Critical Habitat	Protective Regulations
Chinook salmon (*Oncorhynchus tshawytcha*)			
Snake River spring/summer-run	T 4/22/92; 57 FR 14653	12/28/93; 58 FR 68543	6/28/05; 70 FR 37160
Snake River fall-run	T 4/22/92; 57 FR 14653	12/28/93; 58 FR 68543[1]	6/28/05; 70 FR 37160
Sockeye salmon *(O. nerka)*			
Snake River	E 11/20/91; 56 FR 58619	12/28/93; 58 FR 68543	ESA section 9 applies
Steelhead (*O. mykiss*)			
Snake River Basin	T 8/18/97; 62 FR 43937	9/02/05; 70 FR 52630	6/28/05; 70 FR 37160

Note: Listing status 'T' means listed as threatened under the ESA; 'E' means listed as endangered.
[1] Critical habitat for Snake River spring/summer Chinook salmon was revised on 10/25/99 (64 FR 57399).

2.2.1. Status of the Species

This section describes the present condition of the SRSS Chinook salmon, SR fall Chinook salmon, and SR sockeye salmon evolutionarily significant units (ESUs), and the SRB steelhead distinct population segment (DPS). NMFS expresses the status of a salmonid ESU or DPS in terms of likelihood of persistence over 100 years (or risk of extinction over 100 years). NMFS uses McElhany et al.'s (2000) description of a viable salmonid population (VSP) that defines "viable" as less than a 5 percent risk of extinction within 100 years and "highly viable" as less than a 1 percent risk of extinction within 100 years. A third category, "maintained," represents a less than 25 percent risk within 100 years (moderate risk of extinction). To be considered viable, an ESU or DPS should have multiple viable populations so that a single catastrophic event is less likely to cause the ESU/DPS to become extinct, and so that the ESU/DPS may function as a metapopulation that can sustain population-level extinction and recolonization processes (ICTRT 2007). The risk level of the ESU/DPS is built up from the aggregate risk levels of the individual populations and major population groups (MPGs) that make up the ESU/DPS.

Attributes associated with a VSP are: (1) abundance (number of adult spawners in natural production areas); (2) productivity (adult progeny per parent); (3) spatial structure; and (4) diversity. A VSP needs sufficient levels of these four population attributes in order to: safeguard the genetic diversity of the listed ESU or DPS; enhance its capacity to adapt to various environmental conditions; and allow it to become self-sustaining in the natural environment (ICTRT 2007). These viability attributes are influenced by survival, behavior, and experiences throughout the entire salmonid life cycle, characteristics that are influenced in turn by habitat and other environmental and anthropogenic conditions. The present risk faced by the ESU/DPS informs NMFS' determination of whether additional risk will appreciably reduce the likelihood that the ESU/DPS will survive or recover in the wild.

The following sections summarize the status and available information on the species and designated critical habitats considered in this opinion based on the detailed information provided by the ESA Recovery Plan for Snake River Spring/Summer Chinook Salmon & Snake River Basin Steelhead (NMFS 2017a), ESA Recovery Plan for Snake River Fall Chinook Salmon (NMFS 2017b), ESA Recovery Plan for Snake River Sockeye Salmon (NMFS 2015), Biological

Viability Assessment Update for Pacific Salmon and Steelhead Listed Under the Endangered Species Act: Pacific Northwest (Ford 2022), 2022 5-Year Review: Summary & Evaluation of Snake River Spring/Summer Chinook Salmon (NMFS 2022a); 2022 5-Year Review: Summary & Evaluation of Snake River Basin Steelhead (NMFS 2022b); 2022 5-Year Review: Summary & Evaluation of Snake River Fall Chinook Salmon (NMFS 2022c); and 2022 5-Year Review: Summary & Evaluation of Snake River Sockeye Salmon (NMFS 2022d). These documents are incorporated by reference here.

Snake River Spring/Summer Chinook Salmon

The SRSS Chinook salmon ESU was listed as threatened on April 22, 1992 (57 FR 14653). This ESU occupies the Snake River basin, which drains portions of southeastern Washington, northeastern Oregon, and north/central Idaho. Large portions of historical habitat were blocked in 1901 by the construction of Swan Falls Dam, on the Snake River, and later by construction of the three-dam Hells Canyon Complex from 1955 to 1967. Dam construction also blocked and/or hindered fish access to historical habitat in the Clearwater River basin as a result of the construction of Lewiston Dam (removed in 1973 but believed to have caused the extirpation of native Chinook salmon in that subbasin). The loss of this historical habitat substantially reduced the spatial structure of this species. The production of SR spring/summer Chinook salmon was further affected by the development of the eight Federal dams and reservoirs in the mainstem lower Columbia/Snake River migration corridor between the late 1930s and early 1970s (NMFS 2017a).

Several factors led to NMFS' 1992 conclusion that SRSS Chinook salmon were threatened: (1) abundance of naturally produced SRSS Chinook runs had dropped to a small fraction of historical levels; (2) short-term projections were for a continued downward trend in abundance; (3) hydroelectric development on the Snake and Columbia Rivers continued to disrupt Chinook runs through altered flow regimes and impacts on estuarine habitats; and (4) habitat degradation and reduced streamflows existed throughout the region, along with risks associated with the use of outside hatchery stocks in particular areas (Good et al. 2005). On August 18, 2022, in the agency's 5-year review for SRSS Chinook salmon, NMFS concluded that the species should remain listed as threatened (NMFS 2022a).

Current runs returning to the Clearwater River drainages were not included in the SRSS Chinook salmon ESU. Lewiston Dam in the lower mainstem of the Clearwater River was constructed in 1927 and functioned as an anadromous block until the early 1940s (Matthews and Waples 1991). In the 1940s spring and summer Chinook salmon runs were reintroduced into the Clearwater system via hatchery outplants. As a result, when determining the status of SRSS Chinook for ESA listing, NMFS concluded that even if a few native salmon survived the hydropower dams, "the massive outplantings of nonindigenous stocks presumably substantially altered, if not eliminated, the original gene pool" (Matthews and Waples 1991).

Life History. Snake River spring/summer Chinook salmon are characterized by their return times. Runs classified as spring Chinook salmon are counted at Bonneville Dam beginning in early March and ending the first week of June; summer runs are those Chinook salmon adults that pass Bonneville Dam from June through August. Returning adults will hold in deep mainstem and tributary pools until late summer, when they move up into tributary areas and spawn. In general, spring-run type Chinook salmon tend to spawn in higher-elevation reaches of major Snake River tributaries in mid- through late August, and summer-run Chinook salmon tend to spawn lower in Snake River tributaries in late August and September (although the spawning areas of the two runs may overlap).

Spring/summer Chinook spawn typically follow a "stream-type" life history characterized by rearing for a full year in the spawning habitat and migrating in early to mid-spring as age-1 smolts (Healey 1991). Eggs are deposited in late summer and early fall, incubate over the following winter, and hatch in late winter and early spring of the following year. Juveniles rear through the summer, and most overwinter and migrate to sea in the spring of their second year of life. Depending on the tributary and the specific habitat conditions, juveniles may migrate extensively from natal reaches into alternative summer-rearing or overwintering areas. Portions of some populations also exhibit "ocean-type" life history, migrating to the ocean during the spring of emergence (Connor et al. 2001; Copeland and Venditti 2009). Snake River spring/summer Chinook salmon return from the ocean to spawn primarily as 4- and 5-year-old fish, after 2 to 3 years in the ocean. A small fraction of the fish returns as 3-year-old "jacks," heavily predominated by males (Good et al. 2005).

Spatial Structure and Diversity. The Snake River ESU includes all naturally spawning populations of spring/summer Chinook in the mainstem Snake River (below Hells Canyon Dam) and in the Tucannon River, Grande Ronde River, Imnaha River, and Salmon River subbasins (57 FR 23458), as well as the progeny of 13 artificial propagation programs (85 FR 81822). The hatchery programs include the McCall Hatchery (South Fork Salmon River), South Fork Salmon River Eggbox, Johnson Creek, Pahsimeroi River, Yankee Fork Salmon River, Panther Creek, Sawtooth Hatchery, Tucannon River, Lostine River, Catherine Creek, Lookingglass Creek, Upper Grande Ronde River, and Imnaha River programs. The historical Snake River ESU also included populations in the Clearwater River drainage and extended above the Hells Canyon Dam complex.

Within the Snake River ESU, the Interior Columbia Technical Recovery Team (ICTRT) identified 28 extant and 4 extirpated or functionally extirpated populations of spring/summer-run Chinook salmon, listed in Table 3 (ICTRT 2003; McClure et al. 2005). The ICTRT aggregated these populations into five MPGs: Lower Snake River, Grande Ronde/Imnaha Rivers, South Fork Salmon River, Middle Fork Salmon River, and Upper Salmon River. For each population, Table 3 shows the current risk ratings for the abundance/productivity and spatial structure/diversity VSP risk parameters.

Spatial structure risk is low to moderate for most populations in this ESU (Ford 2022) and is generally not preventing the recovery of the species. Spring/summer Chinook salmon spawners are distributed throughout the ESU albeit at very low numbers. Diversity risk, on the other hand, is somewhat higher, driving the moderate and high combined spatial structure/diversity risks shown in Table 3 for some populations. Several populations have a high proportion of hatchery-origin spawners particularly in the Grande Ronde, Lower Snake, and South Fork Salmon MPGs—and diversity risk will need to be lowered in multiple populations in order for the ESU to recover (ICTRT 2007; ICTRT 2010; Ford 2022).

Table 3. Summary of viable salmonid population (VSP) parameter risks, current status, and proposed recovery goal for each population in the Snake River spring/summer Chinook salmon evolutionarily significant unit (Ford 2022; NMFS 2017a).

Major Population Group	**Population**	**VSP Risk Rating[1]**		**Viability Rating**	
		Abundance/ Productivity	**Spatial Structure/ Diversity**	**2022 Assessment**	**Proposed Recovery Goal[2]**
South Fork Salmon River (Idaho)	Little Salmon River	*Insuf. data*	Low	High Risk	Maintained
	South Fork Salmon River mainstem	High	Moderate	High Risk	Viable
	Secesh River	High	Low	High Risk	Highly Viable
	East Fork South Fork Salmon River	High	Low	High Risk	Maintained
Middle Fork Salmon River (Idaho)	Chamberlain Creek	High	Low	High Risk	Viable
	Middle Fork Salmon River below Indian Creek	High	Moderate	High Risk	Maintained
	Big Creek	High	Moderate	High Risk	Highly Viable
	Camas Creek	High	Moderate	High Risk	Maintained
	Loon Creek	*Insuf. data*	Moderate	High Risk	Viable
	Middle Fork Salmon River above Indian Creek	High	Moderate	High Risk	Maintained
	Sulphur Creek	High	Moderate	High Risk	Maintained
	Bear Valley Creek	Moderate	Low	Maintained	Viable
	Marsh Creek	Moderate	Low	Maintained	Viable
Upper Salmon River (Idaho)	North Fork Salmon River	*Insuf. data*	Low	High Risk	Maintained
	Lemhi River	High	High	High Risk	Viable
	Salmon River Lower Mainstem	High	Low	High Risk	Maintained
	Pahsimeroi River	High	High	High Risk	Viable
	East Fork Salmon River	High	High	High Risk	Viable
	Yankee Fork Salmon River	High	High	High Risk	Maintained
	Valley Creek	High	Moderate	High Risk	Viable
	Salmon River Upper Mainstem	High	Low	High Risk	Highly Viable
	Panther Creek	*Insuf. data*	High	High Risk	***Reintroduction***
Lower Snake (Washington)	Tucannon River	High	Moderate	High Risk	Highly Viable
	Asotin Creek			***Extirpated***	***Consider Reintroduction***
Grande Ronde and Imnaha Rivers (Oregon/ Washington)[3]	Wenaha River	High	Moderate	High Risk	Highly Viable or Viable
	Lostine/Wallowa River	High	Moderate	High Risk	Highly Viable or Viable
	Minam River	Moderate	Moderate	Maintained	Highly Viable or Viable
	Catherine Creek	High	Moderate	High Risk	Highly Viable or Viable
	Upper Grande Ronde River	High	High	High Risk	Maintained
	Imnaha River	High	Moderate	High Risk	Highly Viable or Viable
	Lookingglass Creek			***Extirpated***	***Consider Reintroduction***

Major Population Group	Population	VSP Risk Rating[1]		Viability Rating	
		Abundance/ Productivity	Spatial Structure/ Diversity	2022 Assessment	Proposed Recovery Goal[2]
	Big Sheep Creek			***Extirpated***	***Consider Reintroduction***

[1]Risk ratings are defined based on the risk of extinction within 100 years: High = greater than or equal to 25 percent; Moderate = less than 25 percent; Low = less than 5 percent; and Very Low = less than 1 percent.
[2]There are several scenarios that could meet the requirements for ESU recovery (as reflected in the proposed goals for populations in Oregon and Washington). What is reflected here for populations in Idaho are the proposed status goals selected by NMFS and the State of Idaho.
[3]At least one of the populations must achieve a very low viability risk rating.

Abundance and Productivity. Historically, the Snake River drainage is thought to have produced more than 1.5 million adult spring/summer Chinook salmon in some years (Matthews and Waples 1991), yet in 1994 and 1995, fewer than 2,000 naturally produced adults returned to the Snake River (ODFW and WDFW 2022). From the mid-1990s and the early 2000s, the population increased dramatically and peaked in 2001 at 45,273 naturally produced adult returns. Since 2001, the numbers have fluctuated between 32,324 (2003) and 4,183 (2019) (ODFW and WDFW 2022). Productivity is below recovery objectives for all of the populations (NMFS 2017a) and has been below replacement for nearly all populations in the ESU since 2012 (Nau et al. 2021).

As reported in the most recent viability assessment (Ford 2022), the five-year (2015-2019) geometric mean abundance estimates for 26 of the 27 evaluated populations are lower than the corresponding estimates for the previous five-year period by varying degrees, with an average decline of 55 percent. The consistent and sharp declines in 15-year population trends for all populations in the ESU are concerning, with the abundance levels for some populations approaching similar levels to those of the early 1990s when the ESU was listed (NMFS 2022a). No populations within the ESU meet the minimum abundance threshold designated by the ICTRT (NMFS 2022a), and the vast majority of the extant populations are considered to be at high risk of extinction due to low abundance/productivity (Ford 2022). Therefore, all currently extant populations of Snake River spring/summer Chinook salmon will likely have to increase in abundance and productivity in order for the ESU to recover (Table 3). Information specific to populations within the action area is described in the environmental baseline section.

Summary. Overall, this ESU is at a moderate-to-high risk of extinction. While there have been improvements in abundance/productivity in several populations since the time of listing, the majority of populations experienced sharp declines in abundance in recent years. If productivity remains low, the ESU's viability will become more tenuous. If productivity improves, populations could increase again, similar to what was observed in the early 2000s. This ESU continues to face threats from disease; predation; harvest; habitat loss, alteration, and degradation; and climate change (NMFS 2022a).

Snake River Fall-run Chinook Salmon

The Snake River fall Chinook salmon ESU was listed as threatened on April 22, 1992 (57 FR 14653). This ESU occupies the Snake River basin, which drains portions of southeastern Washington, northeastern Oregon, and north/central Idaho. Snake River fall Chinook salmon have substantially declined in abundance from historic levels, primarily due to the loss of primary spawning and rearing areas upstream of the Hells Canyon Dam complex (57 FR 14653). Additional concerns for the species have been the high percentage of hatchery fish returning to natural spawning grounds and the relatively high aggregate harvest impacts by ocean and in-river fisheries (Good et al. 2005). On August 18, 2022, in the agency's 5-year status review for Pacific salmon and steelhead, NMFS concluded that the species should remain listed as threatened (NMFS 2022a).

Life History. Snake River fall Chinook salmon enter the Columbia River in July and August, and migrate past the lower Snake River mainstem dams from August through November. Fish spawning takes place from October through early December in the mainstem of the Snake River, primarily between Asotin Creek and Hells Canyon Dam, and in the lower reaches of several of the associated major tributaries including the Tucannon, Grande Ronde, Clearwater, Salmon, and Imnaha Rivers (Connor and Burge 2003; Ford 2011). Fall Chinook salmon also occasionally spawn in the mainstem Snake River downstream from Lower Granite Dam (Dauble et al. 1999; Dauble et al. 1995; Dauble et al. 1994; Mueller 2009). Juveniles emerge from the gravels in March and April of the following year.

Most SR fall Chinook salmon exhibit an "ocean-type" life history (Dauble and Geist 2000; Good et al. 2005; Healey 1991; NMFS 1992) wherein they migrate to the Pacific Ocean during their first year of life, normally within 3 months of emergence from the spawning substrate as age-0 smolts, to spend their first winter in the ocean. Ocean-type Chinook salmon juveniles tend to display a "rear as they go" strategy, in which they continually move downstream through shallow shoreline habitats during their first summer and fall, continually growing until reach the ocean by winter (Connor and Burge 2003; Coutant and Whitney 2006). Tiffan and Connor (2012) showed that subyearling fish favor water less than 6-feet deep and Tiffan et al. (2014) found that riverine reaches were likely better rearing habitat than reservoir reaches.

A series of studies in the early 2000s demonstrated that a significant number of SR fall Chinook salmon juveniles exhibit a stream-type life history. These fish arrest their seaward migration and overwinter in reservoirs on the Snake and Columbia Rivers, then resume migration and enter the ocean in early spring as age-1 smolts (Connor and Burge 2003; Connor et al. 2002; Connor et al. 2005; Hegg et al. 2013). Connor et al. (2005) termed this life history strategy "reservoir-type." Scale samples from natural-origin adult fall Chinook salmon taken at Lower Granite Dam have indicated that approximately half of the returns overwintered in freshwater (Ford 2011).

Spatial Structure and Diversity. The SR fall Chinook salmon ESU includes one extant population of fish spawning in the mainstem of the Snake River and the lower reaches of several of the associated major tributaries including the Tucannon, Grande Ronde, Clearwater, Salmon, and Imnaha Rivers. The ESU also includes four artificial propagation programs: the Lyons Ferry Hatchery, Fall Chinook Acclimation Ponds, Nez Perce Tribal Hatchery, and Idaho Power programs (85 FR 81822). Historically, this ESU included one large additional population spawning in the mainstem of the Snake River upstream of the Hells Canyon Dam complex (Ford 2022). The extant population currently spawns in all five of its historic major spawning areas. The spatial structure risk for this population is therefore low and is not precluding recovery of the species (Ford 2022).

There are several diversity concerns for SR fall Chinook salmon, leading to a moderate diversity risk rating for the extant Lower Snake population. One concern is the relatively high proportion of hatchery spawners (70%) in all major spawning areas within the population (Ford 2022; NMFS 2017b). The fraction of natural-origin fish on the spawning grounds has remained relatively stable, with five-year means of 31 percent (2010-2014) and 33 percent (2015-2019) (Ford 2022). The diversity risk will need to be reduced to low in order for this population to be considered highly viable. Because there is only one extant population, it must achieve highly viable status in order for the ESU to recover.

Abundance and Productivity. Historical abundance of SR fall Chinook salmon is estimated to have been 416,000 to 650,000 adults (NMFS 2006), but numbers declined drastically over the 20th century, with only 78 natural-origin fish (WDFW and ODFW 2021) and 306 hatchery-origin fish (FPC 2019) passing Lower Granite Dam in 1990. After 1990, abundance increased dramatically, and exceeded 10,000 natural-origin returns each year from 2012-2015. However, the 5-year geometric means of natural origin-spawners has declined by 36 percent between the 2010-2014 (11,254) and 2015-2019 (7,252) time periods. Although there have been recent declines in natural origin returns, the 10-year geometric mean for the years 2010-2019 (9,034 natural-origin adults) exceeds the recovery plan abundance metric (i.e., > 4,200 natural-origin spawners) (Ford 2022; NMFS 2017b; NMFS 2022c). While the recovery plan abundance metric is currently exceeded, the associated 20-year geometric mean of population productivity is only 0.63, which is far below the recovery plan metric of 1.7.

Summary. The status of this ESU has improved since the time of listing. While the population is currently considered to be viable, it is not meeting its recovery goals. This is due to: (1) low population productivity; (2) uncertainty about whether the elevated natural-origin abundance can be sustained over the long term; and (3) high levels of hatchery-origin spawners in natural spawning areas (NMFS 2022c). This ESU also continues to face threats from tributary and mainstem habitat loss, degradation, or modification; disease; predation; harvest; hatcheries; and climate change (NMFS 2022c).

Snake River Sockeye Salmon

This ESU includes all anadromous and residual sockeye salmon from the Snake River basin in Idaho, as well as artificially propagated sockeye salmon from the Redfish Lake captive propagation and Snake River sockeye salmon hatchery programs (85 FR 81822). The ESU was first listed as endangered under the ESA in 1991, and the listing was reaffirmed in 2005 (70 FR 37160). Reasons for the decline of this species include high levels of historic harvest, dam construction including hydropower development on the Snake and Columbia Rivers, water diversions and water storage, predation on juvenile salmon in the mainstem river migration corridor, and active eradication of sockeye salmon from some lakes in the 1950s and 1960s (56 FR 58619; ICTRT 2003). On August 18, 2022, in the agency's 5-year status review for Pacific salmon and steelhead, NMFS concluded that the species should remain listed as endangered (NMFS 2022a).

Life History. Snake River sockeye salmon adults enter the Columbia River primarily during June and July, and arrive in the Sawtooth Valley peaking in August. The Sawtooth Valley supports the only remaining run of SR sockeye salmon. The adults spawn in lakeshore gravels, primarily in October (Bjornn et al. 1968). Eggs hatch in the spring between 80 and 140 days after spawning. Fry remain in the gravel for 3 to 5 weeks, emerging from April through May. Juveniles remain in the natal lake feeding on plankton for 1 to 3 years before they migrate to the ocean, leaving their natal lake in the spring from late April through May (Bjornn et al. 1968). Snake River sockeye salmon usually spend 2 to 3 years in the Pacific Ocean and return to Idaho in their 4th or 5th year of life.

Spatial Structure and Diversity. Within the Snake River ESU, the ICTRT identified historical sockeye salmon production in five Sawtooth Valley lakes, in addition to Warm Lake and the Payette Lakes in Idaho and Wallowa Lake in Oregon (ICTRT 2003). The sockeye salmon runs to warm; Payette, and Wallowa Lakes are now extinct, and the ICTRT identified the Sawtooth Valley lakes as a single MPG for this ESU. The MPG consists of the Redfish, Alturas, Stanley, Yellowbelly, and Pettit Lake populations (ICTRT 2007). The only extant population is Redfish Lake, which is highly dependent on a captive broodstock program operated at the Sawtooth Hatchery and Eagle Hatchery. Although the captive brood program rescued the ESU from extinction, the diversity risk remains high and will continue to remain high without sustainable natural production (Ford 2022).

Hatchery fish from the Redfish Lake captive propagation program have been outplanted in Alturas and Pettit Lakes since the mid-1990s in an attempt to reestablish those populations, thus improving spatial structure of the ESU (Ford 2011). There is some evidence of very low levels of early-timed returns in some recent years from outmigrating, naturally-produced Alturas Lake smolts, but the ESU remains at high risk for spatial structure. With such a small number of populations in this MPG, the reestablishment of any additional populations would substantially reduce the risk faced by the ESU (ICTRT 2007).

Abundance and Productivity. Prior to the turn of the 20th century (ca. 1880), around 150,000 sockeye salmon ascended the Snake River to the Wallowa, Payette, and Salmon River basins to spawn in natural lakes (Evermann 1896, as cited in Chapman et al. 1990). The Wallowa River sockeye salmon run was considered extinct by 1905, the Payette River run was blocked by Black Canyon Dam on the Payette River in 1924, and anadromous Warm Lake sockeye salmon in the South Fork Salmon River basin may have been trapped in Warm Lake by a land upheaval in the early 20th century (ICTRT 2003). In the Sawtooth Valley, the Idaho Department of Fish and Game eradicated sockeye salmon from Yellowbelly, Pettit, and Stanley Lakes in favor of other species in the 1950s and 1960s, and irrigation diversions led to the extirpation of sockeye salmon in Alturas Lake in the early 1900s (ICTRT 2003), leaving only the Redfish Lake sockeye salmon population. From 1991 to 1998, a total of just 16 wild adult anadromous sockeye salmon returned to Redfish Lake. These 16 wild fish were incorporated into a captive broodstock program that began in 1992 and has since expanded. The program currently releases hundreds of thousands of juvenile fish each year in the Sawtooth Valley (Ford 2011).

The increased abundance of hatchery reared SR sockeye salmon reduces the risk of extinction over the short-term, but levels of naturally produced sockeye salmon returns are variable and remain extremely low (Ford 2022). The ICTRT's viability target is at least 1,000 naturally produced spawners per year in each of Redfish and Alturas Lakes and at least 500 in Pettit Lake (ICTRT 2007). The highest adult returns since the captive broodstock program began were in

2014, with a total of 1,579 counted in the Stanley Basin (Ford 2022). The general increases observed in the number of adult returns during 2008-2014 were likely due to a number of factors, including increases in hatchery production and favorable marine conditions. The 5-year geometric mean of natural-origin adult returns was 137 for 2010-2014. Since then, natural-origin adult returns have declined with a 2015-2019 5-year geometric mean of 16 (Ford 2022). Adult returns crashed in 2015 due to a combination of low flows and warm water temperatures in the migration corridor. There was also high in-basin mortality of smolts released in 2015-2017 due to water chemistry shock between hatchery waters and the water of Redfish Lake (Ford 2022). The total number of returning adults documented in the Sawtooth Valley in 2020 was 152 (Dan Baker, IDFG, email sent to Chad Fealko, NMFS, November 2, 2021 regarding 2020 sockeye salmon returns). The recent general decline is in part due to poor survival and growth in the ocean.

The species remains at high risk across all four parameters (spatial structure, diversity, abundance, and productivity). Although the captive brood program has been highly successful in producing hatchery sockeye salmon, substantial increases in survival rates across all life history stages must occur in order to reestablish sustainable natural production (Ford 2022). In particular, juvenile and adult losses during travel through the Salmon, Snake, and Columbia River migration corridor continue to present a significant threat to species recovery (NMFS 2022d).

Summary. Considering the limited to extremely low levels of natural production, the high spatial structure and diversity risks, and climate change vulnerability; the viability of the SR sockeye salmon ESU has likely declined in recent years and the ESU is at a high risk of extinction within 100 years. This ESU continues to face threats from habitat modification and degradation through the migratory corridor, predation, disease, and climate change (NMFS 2022d).

Snake River Basin Steelhead

The SRB steelhead was listed as a threatened ESU on August 18, 1997 (62 FR 43937), with a revised listing as a DPS on January 5, 2006 (71 FR 834). This DPS occupies the Snake River basin, which drains portions of southeastern Washington, northeastern Oregon, and north/central Idaho. Reasons for the decline of this species include substantial modification of the seaward migration corridor by hydroelectric power development on the mainstem Snake and Columbia Rivers, loss of habitat above the Hells Canyon Dam complex on the mainstem Snake River, and widespread habitat degradation and reduced streamflows throughout the Snake River basin (Good et al. 2005). Another major concern for the species is the threat to genetic integrity from past and present hatchery practices, and the high proportion of hatchery fish in the aggregate run of SRB steelhead over Lower Granite Dam (Good et al. 2005; Ford 2011). On August 18, 2022, in the agency's 5-year status review for Pacific salmon and steelhead, NMFS concluded that the species should remain listed as threatened (NMFS 2022b).

Life History. Adult SRB steelhead enter the Columbia River from late June to October to begin their migration inland. After holding over the winter in larger rivers in the Snake River basin, steelhead disperse into smaller tributaries to spawn from March through May. Earlier dispersal occurs at lower elevations and later dispersal occurs at higher elevations. Juveniles emerge from the gravels in 4 to 8 weeks, and move into shallow, low-velocity areas in side channels and along channel margins to escape high velocities and predators (Everest and Chapman 1972). Juvenile steelhead then progressively move toward deeper water as they grow in size (Bjornn and Rieser 1991). Juveniles typically reside in fresh water for 1 to 3 years, although this species displays a wide diversity of life histories. Smolts migrate downstream during spring runoff, which occurs from March to mid-June depending on elevation, and typically spend 1 to 2 years in the ocean.

Spatial Structure and Diversity. This species includes all naturally-spawning steelhead populations below natural and manmade impassable barriers in streams in the Snake River basin of southeast Washington, northeast Oregon, and Idaho, as well as the progeny of six artificial propagation programs (85 FR 81822). The artificial propagation programs include the Dworshak National Fish Hatchery, Salmon River B-run, South Fork Clearwater B-run, East Fork Salmon River Natural, Tucannon River, and the Little Sheep Creek/Imnaha River programs. The SRB steelhead listing does not include resident forms of *O. mykiss* (rainbow trout) co-occurring with steelhead.

The ICTRT identified 24 extant populations within this DPS, organized into five MPGs (ICTRT 2003). The ICTRT also identified a number of potential historical populations associated with watersheds above the Hells Canyon Dam complex on the mainstem Snake River, a barrier to anadromous migration. The five MPGs with extant populations are the Clearwater River, Salmon River, Grande Ronde River, Imnaha River, and Lower Snake River. In the Clearwater River, the historic North Fork population was blocked from accessing spawning and rearing habitat by Dworshak Dam. Current steelhead distribution extends throughout the DPS, such that spatial structure risk is generally low. For each population in the DPS, Table 4 shows the current risk ratings for the parameters of a VSP (spatial structure, diversity, abundance, and productivity).

Snake River Basin steelhead exhibit a diversity of life-history strategies, including variations in fresh water and ocean residence times. Traditionally, fisheries managers have classified these steelhead into two groups, A-run and B-run, based on ocean age at return, adult size at return, and migration timing. A-run steelhead predominantly spend 1 year in the ocean; B-run steelhead are larger with most individuals returning after 2 years in the ocean. Most Snake River populations support a mixture of the two run types, with the highest percentage of B-run fish in the upper Clearwater River and the South Fork Salmon River; moderate percentages of B-run fish in the Middle Fork Salmon River; and very low percentages of B-run fish in the Upper Salmon River, Grande Ronde River, and Lower Snake River (NWFSC 2015). Maintaining life history diversity is important for the recovery of the species.

The spatial structure risk is considered to be low or very low for the vast majority of populations in this DPS. This is because juvenile steelhead (age-1 parr) were detected in 97 of the 112 spawning areas (major and minor) that are accessible by spawning adults. Diversity risk for populations in the DPS is either moderate or low. Large numbers of hatchery steelhead are released in the Snake River, and while new information about the relative abundance of natural-origin spawners is available, the relative proportion of hatchery adults in natural spawning areas near major hatchery release sites remains uncertain (Ford 2022). Reductions in hatchery-related diversity risks would increase the likelihood of these populations reaching viable status.

Table 4. Summary of viable salmonid population (VSP) parameter risks and overall current status and proposed recovery goals for each population in the Snake River Basin steelhead distinct population segment (Ford 2022; NMFS 2017a; NMFS 2022b).

Major Population Group	Population[2]	VSP Risk Rating[1]		Viability Rating	
		Abundance/ Productivity	**Spatial Structure/ Diversity**	**2022 Assessment**	**Proposed Recovery Goal[3]**
Lower Snake River[4]	Tucannon River	High	Moderate	High Risk	Highly Viable or Viable
	Asotin Creek	Low	Moderate	Viable	Highly Viable or Viable
Grande Ronde River	Lower Grande Ronde	High	Moderate	High Risk	Viable or Maintained
	Joseph Creek	Low	Low	Viable	Highly Viable, Viable, or Maintained
	Wallowa River	High	Low	High Risk	Viable or Maintained
	Upper Grande Ronde	Very Low	Moderate	Viable	Highly Viable or Viable
Imnaha River	Imnaha River	Very Low	Moderate	Viable	Highly Viable
Clearwater River (Idaho)	Lower Mainstem Clearwater River	Very Low	Low	Highly Viable	Viable
	South Fork Clearwater River	Very Low	Moderate	Viable	Maintained
	Lolo Creek	High	Moderate	High Risk	Maintained
	Selway River	Moderate	Low	Maintained	Viable
	Lochsa River	Moderate	Low	Maintained	Highly Viable
	North Fork Clearwater River			*Extirpated*	*N/A*
Salmon River (Idaho)	Little Salmon River	Very Low	Moderate	Viable	Maintained
	South Fork Salmon River	Moderate	Low	Maintained	Viable
	Secesh River	Moderate	Low	Maintained	Maintained
	Chamberlain Creek	Moderate	Low	Maintained	Viable
	Lower Middle Fork Salmon River	Moderate	Low	Maintained	Highly Viable
	Upper Middle Fork Salmon River	Moderate	Low	Maintained	Viable
	Panther Creek	Moderate	High	High Risk	Viable
	North Fork Salmon River	Moderate	Moderate	Maintained	Maintained
	Lemhi River	Moderate	Moderate	Maintained	Viable
	Pahsimeroi River	Moderate	Moderate	Maintained	Maintained
	East Fork Salmon River	Moderate	Moderate	Maintained	Maintained

Major Population Group	Population[2]	VSP Risk Rating[1]		Viability Rating	
		Abundance/ Productivity	Spatial Structure/ Diversity	2022 Assessment	Proposed Recovery Goal[3]
Salmon River (Idaho)	Upper Mainstem Salmon River	Moderate	Moderate	Maintained	Maintained
Hells Canyon	Hells Canyon Tributaries			*Extirpated*	

[1]Risk ratings are defined based on the risk of extinction within 100 years: High = greater than or equal to 25 percent; Moderate = less than 25 percent; Low = less than 5 percent; and Very Low = less than 1 percent.
[2]Populations shaded in gray are those that occupy the action area.
[3]There are several scenarios that could meet the requirements for ESU recovery (as reflected in the proposed goals for populations in Oregon and Washington). What is reflected here for populations in Idaho are the proposed status goals selected by NMFS and the State of Idaho.
[4]At least one of the populations must achieve a very low viability risk rating.

Abundance and Productivity. Historical estimates of steelhead production for the entire Snake River basin are not available, but the basin is believed to have supported more than half the total steelhead production from the Columbia River basin (Mallet 1974, as cited in Good et al. 2005). The Clearwater River drainage alone may have historically produced 40,000 to 60,000 adults (Ecovista et al. 2003), and historical harvest data suggests that steelhead production in the Salmon River was likely higher than in the Clearwater (Hauck 1953). In contrast, at the time of listing in 1997, the 5-year geometric mean abundance for natural-origin steelhead passing Lower Granite Dam, which includes all but one population in the DPS, was 11,462 adults (Ford 2011). Abundance began to increase in the early 2000s, with the single year count and the 5-year geometric mean both peaking in 2015 at 45,789 and 34,179, respectively (ODFW and WDFW 2022). Since 2015, the 5-year geometric means have declined steadily with only 11,557 natural-origin adult returns for the most recent 5-year geometric mean (ODFW and WDFW 2022).

Summary. Based on information available for the 2022 viability assessment, none of the five MPGs are meeting their recovery plan objectives and the viability of many populations remains uncertain. The recent, sharp declines in abundance are of concern and are expected to negatively affect productivity in the coming years. Overall, available information suggests that SRB steelhead continue to be at a moderate risk of extinction within the next 100 years. This DPS continues to face threats from tributary and mainstem habitat loss, degradation, or modification; predation; harvest; hatcheries; and climate change (NMFS 2022b).

2.2.2. Status of Critical Habitat

In evaluating the condition of designated critical habitat, NMFS examines the condition and trends of PBFs which are essential to the conservation of the ESA-listed species because they support one or more life stages of the species. Proper function of these PBFs is necessary to support successful adult and juvenile migration, adult holding, spawning, incubation, rearing, and the growth and development of juvenile fish. Modification of PBFs may affect freshwater spawning, rearing or migration in the action area. Generally speaking, sites required to support one or more life stages of the ESA-listed species (i.e., sites for spawning, rearing, migration, and foraging) contain PBF essential to the conservation of the listed species (e.g., spawning gravels, water quality and quantity, side channels, or food) (Table 5).

Table 5. Types of sites, essential physical and biological features (PBFs), and the species life stage each PBF supports.

Site	Essential Physical and Biological Features	Species Life Stage
Snake River basin steelhead[a]		
Freshwater spawning	Water quality, water quantity, and substrate	Spawning, incubation, and larval development
Freshwater rearing	Water quantity and floodplain connectivity to form and maintain physical habitat conditions	Juvenile growth and mobility
	Water quality and forage[b]	Juvenile development
	Natural cover[c]	Juvenile mobility and survival
Freshwater migration	Free of artificial obstructions, water quality and quantity, and natural cover[c]	Juvenile and adult mobility and survival
Snake River spring/summer Chinook salmon, fall Chinook, and sockeye salmon		
Spawning and juvenile rearing	Spawning gravel, water quality and quantity, cover/shelter (Chinook only), food, riparian vegetation, space (Chinook only), water temperature, and access (sockeye only)	Juvenile and adult
Migration	Substrate, water quality and quantity, water temperature, water velocity, cover/shelter, food[d], riparian vegetation, space, safe passage	Juvenile and adult

[a] Additional PBFs pertaining to estuarine areas have also been described for Snake River steelhead. These PBFs will not be affected by the proposed action and have therefore not been described in this opinion.
[b] Forage includes aquatic invertebrate and fish species that support growth and maturation.
[c] Natural cover includes shade, large wood, log jams, beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks.
[d] Food applies to juvenile migration only.

Table 6 describes the geographical extent of critical habitat within the Snake River basin for each of the four ESA-listed salmon and steelhead species. Critical habitat includes the stream channel and water column with the lateral extent defined by the ordinary high-water line, or the bankfull elevation where the ordinary high-water line is not defined. In addition, critical habitat for the three salmon species includes the adjacent riparian zone, which is defined as the area within 300 feet of the line of high water of a stream channel or from the shoreline of standing body of water (58 FR 68543). The riparian zone is critical because it provides shade, streambank stability, organic matter input, and regulation of sediment, nutrients, and chemicals.

Table 6. Geographical extent of designated critical habitat within the Snake River basin for ESA-listed salmon and steelhead.

Evolutionarily Significant Unit (ESU)/ Distinct Population Segment (DPS)	Designation	Geographical Extent of Critical Habitat
Snake River sockeye salmon	58 FR 68543; December 28, 1993	Snake and Salmon Rivers; Alturas Lake Creek; Valley Creek, Stanley Lake, Redfish Lake, Yellowbelly Lake, Pettit Lake, Alturas Lake; all inlet/outlet creeks to those lakes.
Snake River spring/summer Chinook salmon	58 FR 68543; December 28, 1993 64 FR 57399; October 25, 1999	All Snake River reaches upstream to Hells Canyon Dam; all river reaches presently or historically accessible to Snake River spring/summer Chinook salmon within the Salmon River basin; and all river reaches presently or historically accessible to Snake River spring/summer Chinook salmon within the Hells Canyon, Imnaha, Lower Grande Ronde, Upper Grande Ronde, Lower Snake–Asotin, Lower Snake–Tucannon, and Wallowa subbasins.
Snake River fall Chinook salmon	58 FR 68543; December 28, 1993	Snake River to Hells Canyon Dam; Palouse River from its confluence with the Snake River upstream to Palouse Falls; Clearwater River from its confluence with the Snake River upstream to Lolo Creek; North Fork Clearwater River from its confluence with the Clearwater River upstream to Dworshak Dam; and all other river reaches presently or historically accessible within the Lower Clearwater, Hells Canyon, Imnaha, Lower Grande Ronde, Lower Salmon, Lower Snake, Lower Snake–Asotin, Lower North Fork Clearwater, Palouse, and Lower Snake–Tucannon subbasins.
Snake River Basin steelhead	70 FR 52630; September 2, 2005	Specific stream reaches are designated within the Lower Snake, Salmon, and Clearwater River basins. Table 21 in the Federal Register details habitat areas within the DPS's geographical range that are excluded from critical habitat designation.

Spawning and rearing habitat quality in tributary streams in the Snake River varies from excellent in wilderness and roadless areas to poor in areas subject to intensive human land uses (NMFS 2015; NMFS 2017a). Critical habitat throughout much of the Interior Columbia (which includes the Snake River and the Middle Columbia River) has been degraded by intensive 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 streamflows, impaired water quality, and reduction of habitat complexity are common problems for critical habitat in non-wilderness areas. Human land use practices throughout the basin have caused streams to become straighter, wider, and shallower, thereby reducing rearing habitat and increasing water temperature fluctuations.

In many stream reaches designated as critical habitat in the Snake River basin, streamflows are substantially reduced by water diversions (NMFS 2015; NMFS 2017a). 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 SRSS summer Chinook and SRB steelhead in particular (NMFS 2017a).

Many stream reaches designated as critical habitat for these species are listed on the Clean Water Act 303(d) list for impaired water quality, such as elevated water temperature (IDEQ 2020). Many areas that were historically suitable rearing and spawning habitat are now unsuitable due to high summer stream temperatures, such as some stream reaches in the Upper Grande Ronde. Removal of riparian vegetation, alteration of natural stream morphology, and withdrawal of water for agricultural or municipal use all contribute to elevated stream temperatures. Water quality in spawning and rearing areas in the Snake River has also been impaired by high levels of sedimentation and by heavy metal contamination from mine waste (e.g., IDEQ and USEPA 2003; IDEQ 2001).

The construction and operation of water storage and hydropower projects in the Columbia River basin, including the eight run-of-river dams on the mainstem lower Snake and lower Columbia Rivers, have altered biological and physical attributes of the mainstem migration corridor. Hydrosystem development modified natural flow regimes, resulting in warmer late summer and fall water temperature. Changes in fish communities led to increased rates of piscivorous predation on juvenile salmon and steelhead. Reservoirs and project tailraces have created opportunities for avian predators to successfully forage for smolts, and the dams themselves have created migration delays for both adult and juvenile salmonids. Physical features of dams, such as turbines, also kill out-migrating fish. In-river survival is inversely related to the number of hydropower projects encountered by emigrating juveniles. However, some of these conditions have improved. The Bureau of Reclamation and U.S. Army Corps of Engineers have implemented measures in previous Columbia River System hydropower consultations to improve conditions in the juvenile and adult migration corridor including 24-hour volitional spill, surface passage routes, upgrades to juvenile bypass systems, and predator management measures. These measures are ongoing and their benefits with respect to improved functioning of the migration corridor PBFs will continue into the future.

Although designated critical habitat for all Snake River species is degraded in places, and in some cases highly degraded, the reduction in accessible area because of the dams increases the conservation value of the remaining watersheds. In addition, the Snake River from the downstream end of the action area (Ice Harbor Dam) is the essential link to all upstream natal streams. The lower Snake River in the action area connects every watershed and population for SRSS Chinook salmon, SR fall Chinook salmon, SR sockeye salmon ESUs, and the SRB steelhead DPS with the ocean, and is used by rearing and migrating juveniles, and spawning and migrating adults.

2.2.3. Climate Change Implications for ESA-listed Species and their Critical Habitat

One factor affecting the rangewide status of Snake River salmon and steelhead, and aquatic habitat at large is climate change. As observed by Siegel and Crozier in 2019, long-term trends in warming have continued at global, national, and regional scales. 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). The year 2020 was another hot year in national and global temperatures; it was the second hottest year in the 141-year record of global land and sea measurements and capped off the warmest decade on record (https://www.ncdc.noaa.gov/sotc/global202013). Events such as the 2013–2016 marine heatwave (Jacox et al. 2019) have been attributed directly to anthropogenic warming, as noted in the annual special issue of Bulletin of the American Meteorological Society on extreme events (Herring et al. 2018). The U.S. Global Change Research Program (USGCRP) reports average warming in the Pacific Northwest of about 1.3ºF 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 (predictions based on a variety of emission scenarios including B1, RCP4.5, A1B, A2, A1FI, and RCP8.5 scenarios). The increases are projected to be largest in summer (Melillo et al. 2014; USGCRP 2018).

Climate change is expected to alter freshwater, estuarine, and marine habitats. Salmon and steelhead rely on these habitats, making these species particularly vulnerable to climate change. In the marine environment, climate change will impact the physiochemical characteristics, including but not limited to increased sea surface temperatures, increased salinity, acidification, and decreased dissolved oxygen. Not only will these changes have physiological consequence on fish themselves, but they will also alter food webs, reducing ocean productivity for salmonids (Crozier et al. 2020; Siegel and Crozier 2019). Climate change is likely to lead to a preponderance of low productivity years (Crozier et al. 2020). Climate change will have similar impacts on estuarine environments, including sea level rise, increased water temperature, and increased salinity (Wainwright and Weitkamp 2013; Limburg et al. 2016; Kennedy 1990). Like the marine environment, these physiochemical changes will influence biological communities and salmonid productivity.

Several studies have revealed that climate change has the potential to affect ecosystems in nearly all tributaries throughout the Snake River (Battin et al. 2007; ISAB 2007). While the intensity of effects will vary by region (ISAB 2007), climate change is generally expected to alter aquatic habitat 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, watersheds will see their runoff diminished 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. Islam et al. (2019) found that air temperature accounted for about 80 percent of the variation in stream temperatures in the Fraser River, thus tightening the link between increased air and water temperatures.

Higher water temperatures, lower flows during summer and fall, and increased magnitude of winter peak flows are all likely to increase salmon mortality or reduce fitness of surviving fish (Mantua et al. 2009; Battin et al. 2007; Beechie et al. 2013; Wainwright and Weitkamp 2013; Whitney et al. 2016). For example, winter flooding may lead to scouring of redds, reducing egg survival. Altered hydrographs may alter the timing of smolt migration and lower summer flows will increase competition for limited space and resources. Elevated water temperatures could increase metabolic rates (and therefore food demand), impede migration, decrease disease resistance, increase physiological stress, and reduce reproductive success. As climate change progresses and stream temperatures warm, thermal refugia will be essential to persistence of many salmonid populations (Mantua et al. 2009).

Climate change is expected to alter critical habitat by generally increasing temperature and peak flows and decreasing base flows. 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.

In summary, climate change is expected to make recovery targets for salmon and steelhead populations more difficult to achieve as a result of its impacts on freshwater, estuarine, and ocean conditions. Climate change is expected to alter critical habitat within the Snake River basin by generally increasing water temperature and peak flows and decreasing base flows. Although these changes will not be spatially homogenous, effects of climate change are expected to decrease the capacity of freshwater critical habitat to support successful spawning, rearing, and migration. Climate will also impact ocean productivity, and is likely to lead to a preponderance of low productivity years (Crozier et al. 2020). Reductions in ocean productivity can reduce the abundance and productivity of salmon and steelhead. Habitat restoration actions can help ameliorate some of 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 begins (at the downstream end) at the confluence of the Snake River with the Columbia River at RM 0. The action area in the Snake River extends upstream to the confluence with the Clearwater River (approximately RM 139), and from RM 0 to approximately RM 2 on the Clearwater River. The action area also includes upland areas used for staging equipment or other logistical support. The action area boundaries encompass the entire lower Snake River navigation channel due to effects of navigation by large vessels (consisting almost exclusively of barge traffic) that is facilitated by dredging. The footprint of the dredging and filling effects are a small portion of the action area.

The species of listed anadromous fish in the action area are SRSS-run (SRSS) Chinook salmon, SR fall Chinook salmon, SR sockeye salmon, and SRB steelhead (Table 1). Both adult and juvenile life stages of the Snake River species use the action area as a migration corridor. In addition, SR fall Chinook salmon spawn in some areas of the mainstem Snake and Clearwater Rivers, primarily upstream of the action area but occasionally in the tailrace areas of the mainstem dams. The portions of the mainstem Snake and Clearwater Rivers in the action area also provide adult holding habitat and rearing habitat for SR fall Chinook salmon, SRSS Chinook salmon and SRB steelhead. The action area is also designated as EFH for Chinook salmon and coho salmon (PFMC1999).

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).

NMFS describes the environmental baseline in terms of the biological requirements for habitat features and processes necessary to support all life stages of each of the four ESA-listed species within the action area. The species considered in this Opinion reside in or migrate through the action area. Thus, for this action area, the biological requirements for SRSS Chinook salmon, SRF Chinook salmon, SR sockeye salmon, and SRB steelhead are the habitat characteristics that support successful completion of spawning, rearing, and migration. An environmental baseline that does not meet the biological requirements of a listed species may increase the likelihood that adverse effects of the proposed action will result in jeopardy to a listed species or in destruction or adverse modification of a designated critical habitat.

Federal Hydropower System. The lower Snake River is confined and controlled by four hydroelectric, concrete, run-of-the river dams, all part of the Columbia River System (CRS). The three lower dams, Ice Harbor, Lower Monumental and Little Goose each create a reservoir that extends upstream to the next dam. The fourth dam, Lower Granite creates a reservoir that extends 46 miles upstream to Asotin, Washington. At RM 139.2, the Clearwater River enters the reservoir at Lewiston Idaho.

Current conditions within much of the mainstem Snake and Clearwater Rivers are degraded relative to historic conditions. Dams and their associated reservoirs have modified much of the mainstem habitat downstream of the Clearwater River confluence previously used by SR fall

Chinook salmon for spawning and altered the functional capacity of the habitat for all rearing and migrating salmon and steelhead. Formerly complex habitat in the mainstem and lower tributaries of the Snake River have been reduced, for the most part, to single channels with reduced or disconnected floodplains, side channels or off-channel habitats (Sedell and Froggatt 1984; Ward and Stanford 1995).

Hydroelectric dams have eliminated or reduced mainstem spawning and rearing habitat and have altered the normal flow regime of the Snake and Clearwater Rivers, decreasing spring and summer flows, increasing fall and winter flow and altering natural thermal patterns (Coutant 1999). Power operations cause fluctuating flow levels and river elevations, affecting fish movement through the reservoirs, disturbing shoreline or shallow water areas and possibly stranding fish in shallow areas when flows recede quickly. A substantial fraction of the mortality experienced by juvenile outmigrants through the portion of the migratory corridor affected by the CRS occurs in the reservoirs.

Survival for juvenile salmonids migrating through the CRS from the Lower Granite Trap to Bonneville Dam has averaged 48.5% for SR spring/summer Chinook salmon and 46.1% for SRB steelhead from 1997-2020 (Widener et al. 2021). Direct survival testing at individual dams indicate that on average less than 4% of spring migrants perish at each dam (Fredricks 2017). Based on average reach and dam mortality estimates, approximately half of the mortality in the CRS occurs in the reservoirs.

Columbia River reservoirs, including those in the lower Snake, have significantly changed instream productivity and ecology, and thus food availability for rearing salmonids, as compared to when the river was free-flowing (ISAB 2011). Primary production by benthic algae and aquatic macrophytes is limited by the scarcity of lotic, backwater, floodplain pool, and other shallow-water habitats, all of which have been reduced or eliminated by the impoundments. Fluctuating water levels result in desiccation of the shorelines, with depths too great to allow adequate light penetration for growth and fine-sediment substrates unsuitable for periphyton. Organic inputs from terrestrial sources, typically of relatively less importance in larger streams and rivers than in smaller streams (Webster and Meyer 1997), have been further reduced by the loss of floodplain and riparian habitat and the associated channel complexity. Rather than the historical lotic benthic invertebrate fauna that inhabited the Columbia River before impoundment (e.g. caddisflies, mayflies, dipterans, mollusks, and gammarid amphipods), soft reservoir sediments now support benthic communities dominated by oligochaetes and immature stages of dipterans (ISAB 2011). These changes in food webs are likely to have reduced the nutritional condition and fitness of migrating juvenile salmon compared to the undeveloped system.

Where the impoundments have created sloughs and backwater habitats, low water exchange and higher late summer water temperatures create habitats favorable to warm water species (Gadomski and Barfoot 1998). Future increases in temperature, due to ongoing climate change, will favor further expansion of warmwater piscivores, particularly largemouth bass and channel catfish (Poe et al. 1991). Non-native piscivorous fishes such as centrarchids (e.g., bass, bluegill, and crappies) and percids (e.g., walleye and perch) have expanded their distributions and numbers (Poe et al. 1994). Beyond changes in species composition, the nonnative fishes change food web dynamics by increasing predation on native fishes, competing for resources, and contributing pathogens and parasites. Future changes in run-of-the-river food webs can be expected as new non-native species become established, and these additions also may have unanticipated effects on the nutritional condition and fitness of migrating juvenile salmon (Kareiva et al. 2000).

Ice Harbor Dam and Reservoir*:* Located at RM 9.5, construction began in 1955, completed in 1961. The reservoir stretches upstream to the base of Lower Monumental Dam, 32 miles upstream. The Wallula Channel, formed from the backup of Snake River entering the Columbia River, runs 10 miles (16 km) downstream from the base of the dam.

Lower Monumental Dam and Reservoir: Lake Herbert G. West, which extends 28 miles (45 km) upstream (east) to the base of Little Goose Dam, is formed behind the dam. Construction began in 1961 with the dam and three generators completed in 1969.

Little Goose Dam and Reservoir: Construction began in 1963. The main structure and three generators were completed in 1970. The reservoir, Lake Bryan, runs upstream 37 miles to Lower Granite Dam.

Lower Granite Reservoir: Lower Granite Reservoir is located on the lower Snake River in southeastern Washington. It is the first of eight mainstem impoundments that juvenile salmonids encounter as they migrate seaward, and the last of eight mainstem dams that adults must pass to reach upstream spawning areas. Located at RM 107.5, construction on Lower Granite Dam began in 1965 with the main structure and three generators completed in 1972. This is the most upstream dam in the Snake River system that has a fish ladder to allow anadromous fish to migrate upstream for spawning. The reservoir extends 46 miles upstream to Asotin, Washington. At RM 139.2, the Clearwater River enters the reservoir at Lewiston, Idaho. The reservoir influence on the Snake River ends shortly upstream of Clarkston, Washington. The next dam upstream, Hells Canyon Dam, is at RM 247, approximately 100 river miles upstream from Asotin, Washington. The Snake River between Asotin, Washington and the Hells Canyon Dam is free flowing, although flows are regulated by the dam.

Lower Granite Reservoir is a run-of-the-river reservoir and is operated primarily for hydropower and flood control. Flows can range above 150,000 cubic feet per second (cfs) in the spring to lows around 16,000 cfs in the winter. The reservoir has an average channel width of 2,080 feet. Water depth averages 56 feet and ranges from less than 3 feet in shallow shoreline areas to a maximum of 137 feet (Tiffan and Hatten 2012). Under current operations, the normal pool elevation typically has a maximum potential fluctuation of about 5 feet. To protect roads and railways, much of the shoreline is lined with riprap (Tiffan and Hatten 2012). In the lower one-half of the reservoir, natural shorelines are generally steep, often characterized by cliffs and talus substrate with little riparian vegetation.

A study of the available rearing habitat in Lower Granite Reservoir by Tiffan and Hatten (2012) estimated that 44% of the shoreline of the reservoir is lined with riprap. Most riprapped shorelines were located along the road and railway along the north side of the reservoir and along the roadway on the south side of the reservoir from Silcott Island to Clarkston, Washington. The entire shoreline of the Clearwater River within the action area (RM 0 to 1.9) is lined with riprap.

In addition, estimates of shallow water rearing habitat, areas less than 6 feet deep, found only 217 acres or 2.2% of the reservoir area is suitable juvenile shallow water rearing habitat.

In addition, numerous anthropogenic features or activities in the action area (e.g., dams, ports, docks, roads, railroads, bank stabilization, irrigation withdrawals, 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., litter fall, channel complexity, and large wood recruitment) to occur is diminished and aquatic habitat has become simplified. Shoreline development has reduced the quantity and quality of nearshore salmon and steelhead habitat by eliminating native riparian vegetation, displacing shallow water habitat with fill materials, and by disconnecting the Snake River from historic floodplain or side channel 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 invasive, non-native species. The riparian system is fragmented, poorly connected, and provides inadequate protection of habitats and refugia for sensitive aquatic species.

Snake River Navigation Channel. The Corps maintains a navigation system in the Snake River that enables barges, and other large vessels that require a minimum depth of 14 feet, to travel upstream in the Snake River, from Ice Harbor Dam to Lewiston, Idaho. The Snake River navigation channel extends approximately 140 miles, from the confluence of the Columbia and Snake Rivers at Pasco, Washington, to the confluence of the Clearwater and Snake Rivers, and a short distance upstream in the Clearwater River to the Port of Lewiston, at Lewiston, Idaho.

Approximately 10 million tons of commercial cargo is transported on the lower Snake River each year with an annual value of between 1.5 and 2 billion dollars. Downbound movements (i.e., movements from upstream ports toward the Columbia River) of grain account for most of this cargo, of which the largest share is wheat. Approximately half of all the wheat exported from export terminals in the lower Columbia River arrive by barge.

Congress has funded multiple navigation channel maintenance (dredging) actions for the lower Snake River navigational channel since the 1980s, including the most recent in the winter of 2015, to restore the navigation channel to the congressionally authorized dimensions (14 feet deep and 250 feet wide). Channel maintenance by dredging has occurred periodically since 1961 and is an anticipated action necessary to keep the channel operating for its designated navigational uses. Navigation channel maintenance has not occurred since 2015.

The federal navigation channel through the lower Snake River affects all four listed anadromous fish species through effects of barges and dredging that is needed to maintain a shipping channel. The effects of ongoing barge operations on critical habitat include spillage or leakage of contaminants (such as fuels, oils, greases), generation of wakes and turbidity by moving vessels, and through creation of overhead shade when shipping vessels are moored. Barge traffic has likely caused minor effects to fish through direct impacts of moving vessels, and the habitat effects described above. Effects of shipping vessels are limited in severity due to physical characteristics of the Snake River and the size of the vessels that can navigate the river. The river is relatively wide, which allows fish ample room to avoid moving barges and dredging effects.

The 14-foot depth of the navigation channel also limits commercial traffic to barges which have a shallow draft that is not capable of producing high-amplitude wakes that might strand fish or cause trauma from the wave energy. While barges are moored, the vessels may serve as overhead cover that might be used by fish that prey on juvenile salmonids. The future effects of barges are discussed in greater detail in the Effects section of this Opinion.

Dredging needed to maintain the navigation channel increases water depth at dredge sites for an indeterminate duration that may vary from a year to several decades, depending on the rate of sediment accumulation. There are 48 locations where sediment accumulation has required dredging in the past or where sediment accumulation presents a potential problem in the future. Dredged material has been used to create shallow benches along the shore. The changes in depth have no effect on habitat value beyond the immediate areas where dredging or disposal occur. The overall habitat value has been little changed by the dredging since the amount of area that has been dredged is a small portion of the river relative to the size of the action area, and the increased depth at the dredge sites is of little consequence to listed fish or their predators. The shallow bench area created by in-water sediment disposal is beneficial to subyearling fall Chinook salmon, but the benefits have minor significance since the shallow bench habitat created by sediment disposal is a relatively small area.

Sediment Accumulation in the Action Area. The existence and operation of the lower Snake River dams and reservoirs prevent the normal transport and deposition of sediment throughout the system. Under a normative flow, without the dams, fine-grained material tends to be deposited on the river floodplain, high on the channel margins and in low velocity side channels and off-channel areas. Under a normative flow, the riverbed would be a complex mosaic of substrate materials with a variety of pools, runs and shallow areas built and rebuilt. The alluvial riffle areas that previously collected suitable spawning gravel for SR fall Chinook salmon are now found in the tailraces of the dams and upstream of the action area. Currently there are very few natural, shallow water, sandy shoals downstream of the Snake and Clearwater confluence area. As a result, juveniles that use shallow water areas to rest and feed during seaward migrations (and SR fall Chinook juveniles that reside in the reservoirs for a year) must travel significant distances between foraging areas.

Most sediment entering Lower Granite Reservoir deposits near the confluence of the Snake and Clearwater Rivers. Historically, the Corps has periodically removed some of this material by dredging to provide access to ports and to maintain the navigation channel. In the past, the Corps has used dredge material to create shallow water benches, primarily for subyearling Snake River Fall Run (SRF) Chinook salmon habitat. This approach was used in 1989 to construct a 0.91-acre island in Lower Granite Reservoir (Centennial Island RM 119; (Chipps *et al*. 1997)) and in 2006 and 2015 to create shallow water habitat at Knoxway Bench (RM 116.6). The shallow-water habitats surrounding Centennial Island are heavily used by subyearlings and Knoxway Bench is also used (Tiffan and Connor 2012).

Of particular significance to this consultation, the lower Snake River dams have severely disrupted the sediment transport with the river channel. The confluence of the lower Snake River and Clearwater Rivers, where most of the dredging will occur, is the approximate point of the river-to-reservoir interface for the Lower Granite reservoir. Lewiston, Idaho, and Clarkston, Washington bound the confluence (Figure 10).

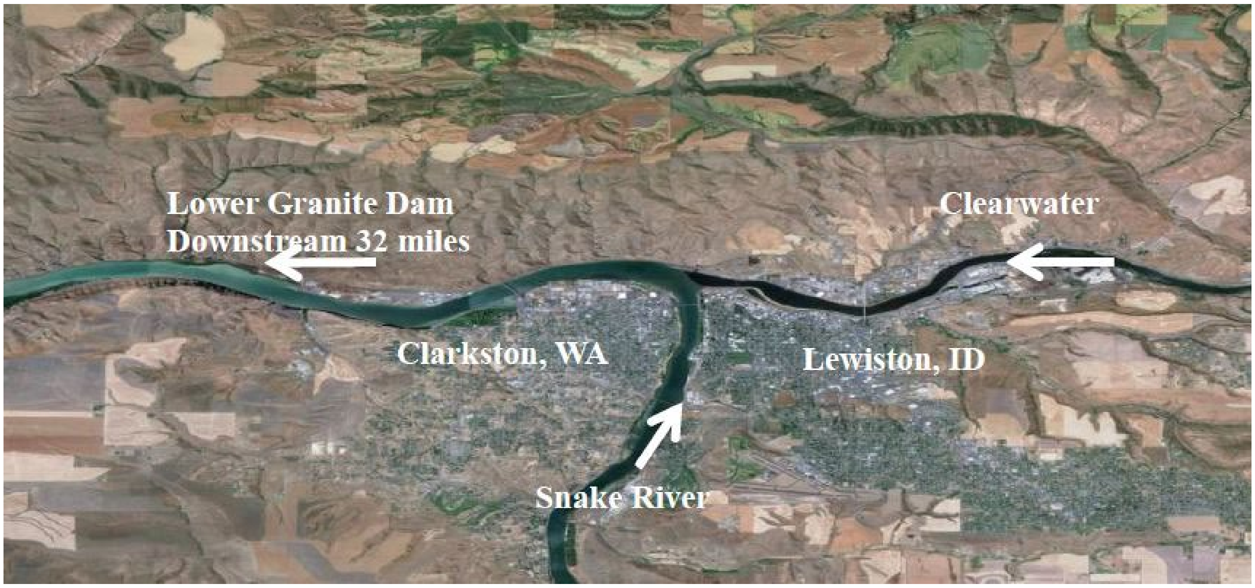

Figure 10. Overhead view of the Snake River and Clearwater River confluence.

The combination of river-to-reservoir interface and the confluence of the two rivers cause both rivers to lose energy. The result is an ongoing deposition of sediment within the confluence area. The material deposited in this area is primarily sand; most of the larger material drops out farther upstream where the rivers start to slow. The Snake River downstream of the confluence annually transports approximately 3 to 4 million cubic yards of new sediments. The Corps estimates that 100 to 150 million cubic yards of sediment have been deposited upstream of the four lower Snake River dams (mostly in Lower Granite Reservoir) since Ice Harbor Dam became operational in 1961.

Sediment samples collected in 2011 and 2019 in the main navigation channel in the confluence area indicate that sand is the dominant material in the navigation channel combined with small amounts of silt near the mooring (shoreline) areas. At the Ice Harbor navigation lock the dredged material is mostly gravel and cobble, from 2 to 6 inches and larger, similar to the riverbed materials in adjacent areas outside the navigation channel and below the dam. The Corps believes the source of this material to be a redistribution of local riverbed material caused by flow passing through the spillways during high flows and sloughing from the steep slopes of the channel through hydraulic action of barge guidance in the lock and passage through the lock.

NMFS has completed ESA section 7 consultation on numerous activities that involve sediment delivery or sediment delivery reduction that may affect the existing sediment deposited in the Lower Granite Reservoir. Those actions have occurred primarily many miles upstream of the action area in the Clearwater River basin, Salmon River basin, or Grande Ronde River basin. Most of those actions have been permitted or carried out by the US Forest Service, Bureau of Land Management, Federal Highway Administration, or Corps. Those land, road, and streambank/streambed management activities have involved a relatively small amount of sediment compared to the natural and other anthropogenic sediment sources that are in the baseline. Those consultations have also been designed to minimize sediment delivery from the proposed activities. NMFS has consulted with the Corps, Bonneville Power Administration, and the U. S. Bureau of Reclamation on the operation of the Columbia River System (CRS).

Water Quality and the Presence of Contaminants in the Action Area. In the Snake River and its tributaries upstream of the action area, the collective effects of agriculture and its irrigation storage reservoirs, hydropower development, mining, forestry, grazing, and urbanization have combined to negatively affect the environmental baseline for water and sediment quality in the action area. All populations of Snake River salmon ESUs and the SRB steelhead DPS depend upon the Snake River in the action area, and downstream reaches of the lower Snake River and Columbia River, for juvenile rearing and migration and adult migration routes between the Pacific Ocean and spawning areas in Idaho and eastern Oregon.

Temperature, dissolved oxygen, and pH are water quality impairment pollutants in the Snake River where it flows into Lower Granite Reservoir LGR (WDOE 2021) and the action area in Idaho and Washington. Dissolved oxygen levels in the Snake River at the head of the LGR may be quite low from early summer to fall, because dissolved oxygen is primarily reduced by high water temperatures (NMFS 2004; EPA 2020). Dissolved oxygen concentration at the upstream monitoring location on the Snake River ranged from 5.9 mg/L to 14.4 mg/L, with a mean of 8.59 mg/L (EPA 2019, 2020).

The Corps conducted sampling in 2019 to assess the suitability of dredged materials in the action area for open water disposal near Bishop Bar, Snake River RM 118. Sediments at the proposed placement location were also sampled and tested as part of this characterization. Five reaches of the proposed dredging location were considered separately for Tier 2 (chemical analysis) sampling and characterization purposes. Most of the project reaches were considered to have homogenous material, based on rapid accumulation of river bed sediment, and were sampled with grab samples. Three Port of Clarkston locations closer to the river bank (Grain Elevator, Recreation Dock and Cruise Dock) were considered to have heterogeneous material accumulation of material, and were sampled with core samples.

The 2019 Corps sampling, along with previous sampling, showed a variety of contaminants in water and sediments of the action area. Materials that are also present throughout the lower Snake River and Columbia River downstream of action area include mercury, copper, and other metals; chlorinated pesticides and their degradates (DDT, DDD, DDE), polychlorinated dibenzo-p-dioxins and furans, polychlorinated biphenyls (PCBs), polybrominated diphenyl ethers (PBDEs), Polycylcic Aromatic Hydrocarbons (PAHs), and many others (Hinck et al. 2006; Seiders et al. 2007; Johnson et al. 2006; Johnson et al. 2013a; Alvarez et al. 2014; Counihan et al. 2014; WDOE 2006. Persistent organochlorine pollutants (POPs), some of which were discontinued 15 to 30 years ago, still exceed benchmarks for human health, aquatic life, and fish-eating wildlife in water, bed- sediment, and fish tissue samples in the Snake and Columbia Rivers (Johnson and Norton 2005; Hinck et al. 2006; Seiders et al. 2011; Johnson et al. 2007; Johnson et al. 2013b; Nilsen et al. 2014; Alvarez et al. 2014; WDOE 2021). Arkoosh et al. (2011) found high proportions (42 percent to 94 percent) of juvenile Chinook salmon were exposed to PBT and PAH levels in the action area that could potentially cause adverse effects and that contribute to harmful body burdens and lipid concentrations that continue to be accumulated during rearing and migration in downriver reaches. Thus, Snake River salmonid exposure and bioaccumulation of PBTs occurring in the action area significantly contribute to harmful levels measured in Snake River salmonid juveniles in the Columbia River and estuary (Arkoosh et al. 2011).

Tiffan and Hatten (2012) estimated 44 percent of LGR shoreline is comprised of riprap. Almost the entire shoreline of the Lewiston unincorporated area along the Snake and Clearwater Rivers is hardscaped with riprap. The Lewiston levees that extend 7.6 miles mostly along the lower Clearwater River are practically devoid of vegetation or trees (EPA 2020). This lack of vegetation along with the hardscape shoreline and channel modification reduces the function and value of salmonid habitat, resulting in a reduction in prey in the action area, and increased floodplain water temperatures (EPA 2020; USACE 2005; Nitoiu and Beltrami 2005; Henning et al. 2006; Jorgensen et al. 2013). To prevent growth of vegetation, levees are treated with highly toxic formulations and mixtures of terrestrial herbicides (Roundup, diquat, and others); this practice of levee management has not undergone ESA section 7 consultation (NMFS 2019; NMFS 2012).

The Corps changes pool elevations of LGR and/or dredges the lower Clearwater River and confluence area seasonally and every few years as needed to maintain navigation access (NMFS 2014b). Dredge spoils are disposed of in-water within LGR (Bennett et al. 1995; Gottfried et al. 2011; NMFS 2014b), where variable water levels may repeatedly resuspend potentially contaminated sediment and redistribute it farther downriver (Tremblay and Lucotte 1997). Using dredge spoils to create shallow water habitat that was lost from the inundation of LGR, has attracted increased use by juvenile salmonids (Gottfried et al. 2011), although risk from contaminated sediments continues. Hydropower, navigation, industry, urbanization, agriculture, levees, and widespread bank armoring have adversely impacted habitat in the action area. These altered habitats reduce survival and growth of listed salmonids in the action area by contributing to elevated water temperature, increased chemical contamination, and the proliferation of invasive plants, invertebrates, and warm water fish predators and competitors (NMFS 2019; Erhardt et al. 2018; Tiffan et al. 2020; Tiffan et al. 2014; Tiffan et al. 2016; Garland et al. 2002; Li et al. 1984).

Presence of Species and Critical Habitat. The entire action area is designated critical habitat for all four listed species of anadromous fish. Fish presence in the action area consists of different size groups and age classes of salmon and steelhead during migration, adult SR fall Chinook spawning (possibly in dam tailraces) starting in late October, incubating eggs through the winter, alevins and fry in the spring. Juveniles, primarily SR fall Chinook with smaller numbers of SRSS Chinook and steelhead, rear in the reservoirs year-round. The majority of adult upstream migration begins at Ice Harbor and Lower Granite Dams in early April and continues until the end of November with the occasional adult Chinook or steelhead still moving upstream in December (Table 7). Recent data show adult steelhead move upstream most months of the year, but between November and April will often hold in deep water in the mainstem until winter or spring flows increase in the tributaries enough for them to complete migration into headwater streams.

All 28 populations (five MPGs) of SRSS Chinook salmon use the action area. Similarly, all 24 extant populations (five MPGs) of SRB steelhead use the action area. The SR fall Chinook ESU is only composed of one population thus this population is in the action area. All extant SR sockeye are part of the Redfish population and this population is in the action during certain times of the year.

Table 7. Ten-year average (2012-2021) historical run timing for adults of each species at Ice Harbor and Lower Granite Dams. Data include natural and hatchery-origin fish, and only includes information for fish that are PIT-tagged. Source: Columbia Basin Research DART (2022).

ESU/DPS	Ice Harbor Dam 1st – last (95th percentile)	Lower Granite Dam 1st – last (95th percentile)
SRSS Chinook salmon	4/20 – 9/18 (7/19)	4/30 – 9/24 (7/23)
SR fall Chinook salmon	6/22 – 11/13 (10/10)	6/10 – 11/20 (10/16)
SR sockeye salmon	6/25 – 7/26 (7/16)	6/28 – 8/25 (8/3)
SRB steelhead	1/9 – 12/26 (11/5)	2/16 – 12/22 (11/8)

Movement rates of migrating juvenile salmon are slower in lower velocity and colder water. Yearling smolts may migrate through LGR in a few days or weeks, feeding each day. Natural-reared salmonids are typically smaller than hatchery fish, smaller sub-yearlings and yearlings tend to feed on smaller-bodied invertebrates, and smaller fish tend to rear in shallow water shoreline habitats of the action area for longer periods (Tiffan et al. 2018; Tiffan et al. 2012). The growth of juvenile salmonids is largely determined by the availability, consumption rate, and energy content of prey in freshwater systems (Sergeant and Beauchamp 2006; Tiffan et al. 2014; Grunblatt et al. 2019). These fish must feed to build energy reserves required for migration where they are vulnerable to depleted lipids and starvation or exhaustion, and to predation in lower rivers, estuary, and ocean (Muir and Coley 1996; Macneale et al. 2010; Davis et al. 2018; Erhardt et al. 2018). As described above, the major food source of rearing and migrating salmonids within the action area is benthic invertebrates (Bennett et al. 1983; Bennett et al. 1995; Muir and Coley 1996; Tiffan et al. 2014). Dipterans, Coleoptera, amphipods, and prawns adapted to sand and silt substrates are often of smaller size, burrow into sediments and exhibit extensive vertical migrations to deep sediments each day to reduce predation. These invertebrates may also feed more frequently in biofilms and detritus along reservoir substrates where several types of pollutants settle and may accumulate contaminants at greater concentrations than larger-bodied invertebrates (Farag et al. 1998; Farag et al. 1999). Smaller benthic invertebrates comprise large proportions of salmonid diets in LGR (Tiffan et al. 2014; Bennett et al. 1983). Smaller-bodied sub-yearling Chinook salmon and one-year old sockeye salmon and steelhead typically eat smaller invertebrates (Farag et al. 1998) and rear for longer periods in the Lower Granite Reservoir (LGR) than older and larger juveniles do. Zooplankton and terrestrial insects were also substantial components of salmonid diets historically (Muir and Coley 1996; Tiffan et al. 2014).

Data for the 10-year (2012 to 2021) historical run timing of smolts indicates movement downstream begins in early March at the Lewiston trap on the Snake River and 2 weeks later at the Lower Granite Dam (LGD) (DART 2022). The same years of data for smolts at Lower Monumental Dam (the downstream extent of smolt counts on the Snake River) indicates that 95% of all outmigrating smolts of all species have passed the dam before the first week in

August. Small numbers of Chinook and sockeye smolts have been observed as late as November 1 at LGD and October 1 at Lower Monumental. Because smolt monitoring on the Snake River only occurs between March 26 (Lower Granite, others are April 1) and October 31, there are no dam counts of 'reservoir-type' SR fall Chinook subyearlings moving downstream during the winter. It is likely that SR fall Chinook, SRSS Chinook, and SRB steelhead juveniles will be present in the action area during in-water work. It is unlikely that SR sockeye salmon juveniles will be present in the action area during in-water work.

Tiffan and Connor (2012) conducted a study to describe juvenile fall Chinook salmon use of a selected group of shallow water habitat complexes in the lower Snake River reservoirs from spring 2010 through winter 2011. They found the lowest numbers of juvenile Chinook in Lower Granite Reservoir and the highest numbers in Ice Harbor Reservoir. Tiffan and Connor (2012) also found that the number of Chinook juveniles in LGR declined over the winter while the numbers downstream in Little Goose reservoir increased suggesting that as juveniles grew they moved downstream. Thus, successful migration relies on adequate access to food resources.

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 (see 50 CFR 402.02). 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 the factors set forth in 50 CFR 402.17(a) and (b).

Effects on Species

Effects of the proposed action are expected from the dredging and disposal that will occur between December 15 and March 1, during the work window, though impacts may persist beyond the work window. These effects include:

- Effects to fish from a reduction in water quality from increased suspended sediment;
- Effects to fish from increased exposure to contaminated sediments, leaks or spills of oils and greases from dredge equipment as well as from barge operations supported by the dredging;
- Displacement and/or impingement of fish by dredge and disposal equipment and operations;
- Effects to fish from effects to prey caused by substrate disturbance;
- Effects to fish from barge operations; and
- Potential for injury to fish from exposure to electrical current from the lamprey sampling.

Adult SRB steelhead and juvenile SRB steelhead, juvenile SR fall Chinook salmon and juvenile SRSS Chinook salmon are likely to be present during the in-water work period and have the potential to be exposed to the effects of dredging and disposal activities. All populations and all life stages of the four listed species (including SR sockeye salmon) considered in this opinion will be exposed to the effects of barging activities that are supported by the proposed action.

Consequences of Exposure to Elevated Suspended Sediment

During the 2014/2015 dredging project, several water quality parameters were monitored in near real-time. Turbidity was the main characteristic influenced by the dredging activity in the Snake River. Turbidity values measured in the field were compared to background values and action levels were defined by the states' established criteria. The Ice Harbor monitoring station did not report any turbidity values (hourly averages) above the State of Washington water quality criteria of 5 Nephelometric Turbidity Units (NTU) units above background. For the remaining sites, there were some readings which exceeded the background readings and standards. All of the sites were in compliance at least 94% of the time.

For the current action, dredging and the in-water disposal of dredged materials will disturb the river bottom and suspend a significant volume of fine sediments in the water column. Suspended sediment reduces light penetration and scatters light in a manner that creates turbidity. Suspended sediment can also affect fish through a variety of direct pathways: abrasion (Servizi and Martens 1992), gill trauma (Bash et al 2001), behavioral effects such as gill flaring, coughing, and avoidance (Berg and Northcote 1985; Bisson and Bilby 1982; Servizi and Martens 1992; Sigler *et al*. 1984), interference with olfaction and chemosensory ability (Wenger and McCormick 2013); and changes in plasma glucose levels (Servizi and Martens 1987). These effects of suspended sediment on salmonids generally decrease with particle size and increase with particle concentration and duration of exposure (Bisson and Bilby 1982; Gregory and Northcote 1993; Servizi and Martens 1987, Newcombe and Jensen 1996). The severity of sediment effects is also affected by physical factors such as particle size, hardness and shape, water velocity, and effects on visibility (Bash et al. 2001). Although increased amounts of suspended sediment cause numerous adverse effects on fish and their environment, salmonids are relatively tolerant of low to moderate levels of suspended sediment. Gregory and Northcote (1993) have shown that moderate levels of turbidity (35 to 150 NTU) can accelerate foraging rates among juvenile Chinook salmon, likely because of reduced vulnerability to predators (camouflaging effect).

Although there are many potential adverse effects of suspended sediment on fish, avoidance behavior can mitigate adverse effects when fish are capable of moving to an area with lower concentrations of suspended sediment. Salmon and steelhead typically avoid suspended sediment. Salmonids may move laterally (Servizi and Martens 1992) or downstream to avoid turbid areas (McLeay et al. 1987). Avoidance of turbid water may begin as turbidities approach 30 NTU (Sigler et al. 1984; Lloyd 1987). Servizi and Martens (1992) noted a threshold for the onset of avoidance at 37 NTU (300 mg/l TSS). However, Berg and Northcote (1985) provide evidence that juvenile coho salmon did not avoid moderate turbidity increases when background levels were low, but exhibited significant avoidance when turbidity exceeded a threshold that was relatively high (>70 NTU). Based on turbidity data collected during the 2015 dredging operation, fish should be capable of avoiding the relatively short periods of high turbidity.

During previous dredging efforts in the Snake River, turbidity levels measured at 300 feet and 900 feet downstream from the dredging occasionally ranged from 6 NTU to 15 NTU for several hours and a similar situation is likely to occur under the present action. The average background turbidity levels in the Snake and Clearwater Rivers during the winter dredging period in 2005 and 2006 was less than 5 NTU. Data collected in 2005 and 2006 indicates that background turbidity was lowest at the confluence of the Snake and Clearwater Rivers and increased farther downstream in the Snake River. Monitoring during dredging efforts in 2015 showed similar turbidity levels. The Ice Harbor monitoring site did not experience any exceedance of turbidity levels in 2015 according to Washington state standards of 5 NTU above background station readings. The other monitoring stations saw very low exceedance above the standards. Table 8 shows the average turbidity values above 5 NTU for the 2014/2015 dredging and disposal work. The highest average turbidity at the 900-foot compliance sites was 5.8 NTU above background which occurred for 1 hour.

Table 8. Turbidity monitoring during 2014/2015 dredging actions (USACE 2022). State of Washington compliance level is 5 NTU.

Ice Harbor Downstream Navigation Lock Approach – Site 1				
2015 Monitoring Period	01/08 – 01/14			
Station	300-ft Downstream		900-ft Downstream	
Depth	Shallow	Deep	Shallow	Deep
Total Hours	142	142	142	142
Exceedance Hours	0	0	0	0
Percent in Compliance	100.00	100.00	100.00	100.00
Average Turbidity (NTU) Over Compliance Level	0	0	0	0
RM-116 In-Water Disposal Site – Site 2				
2015 Monitoring Period	01/10 – 02/24			
Station	300-ft Downstream		900-ft Downstream	
Depth	Shallow	Deep	Shallow	Deep
Total Hours	1,070	1,070	1,064	1,064
Exceedance Hours	0	20	0	12
Percent in Compliance	100	98.13	100.00	98.87
Average Turbidity (NTU) Over Compliance Level	0	1.3	0	1.7
Clarkston, Washington – Site 3				
2015 Monitoring Period	01/17 – 01/29			
Station	300-ft Downstream		900-ft Downstream	
Depth	Shallow	Deep	Shallow	Deep
Total Hours	269	269	274	274
Exceedance Hours	14	0	15	0
Percent in Compliance	94.80	100.00	94.16	100.00
Average Turbidity (NTU) Over Compliance Level	3.6	0	3.8	0
Clarkston, Washington – Site 4				
2015 Monitoring Period	01/10 – 02/09			
Station	300-ft Downstream		900-ft Downstream	
Depth	Shallow	Deep	Shallow	Deep
Total Hours	689	689	698	698
Exceedance Hours	3	9	1	13
Percent in Compliance	99.56	98.69	99.86	98.14
Average Turbidity (NTU) Over Compliance Level	2.0	1.3	1.2	2.3
Lewiston, Idaho – Site 4				
2015 Monitoring Period	02/09 – 02/21			
Station	300-ft Downstream		900-ft Downstream	
Depth	Shallow	Deep	Shallow	Deep
Total Hours	283	283	285	284
Exceedance Hours	0	2	0	0
Percent in Compliance	100.00	99.29	100.00	100.00
Average Turbidity (NTU) Over Compliance Level	0	21.9	0	0

Clarkston, Washington – Site 5				
2015 Monitoring Period	01/10 – 02/09			
Station	300-ft Downstream		900-ft Downstream	
Depth	Shallow	Deep	Shallow	Deep
Total Hours	427	427	428	428
Exceedance Hours	4	0	3	0
Percent in Compliance	99.06	100.00	99.30	100.00
Average Turbidity (NTU) Over Compliance Level	4.3	0	1.2	0
Lewiston, Idaho – Site 5				
2015 Monitoring Period	02/09 – 02/21			
Station	300-ft Downstream		900-ft Downstream	
Depth	Shallow	Deep	Shallow	Deep
Total Hours	502	502	502	502
Exceedance Hours	0	1	1	0
Percent in Compliance	100.00	99.80	99.80	100.00
Average Turbidity (NTU) Over Compliance Level	0	3.5	5.8	0

Newcombe and Jensen (1996) developed an index that is used in this opinion to predict the severity of ill effects experienced by fish when exposed to suspended sediment (Box 1). The "severity of ill effects score" (SEV) is based on the concept of a dose-response relationship, where the severity of effect increases in relation to the dosage. Under Newcombe and Jensen's (1996) model, the "dosage" is dependent on the sediment concentration and the duration of exposure, and the SEV score represents the fish's response. The U.S. Fish and Wildlife Service (Muck 2010) developed guidance for using the SEV score to represent thresholds for incidental take, such as "harm," or "harass." The precise thresholds for take vary with different species, lifestages, and the physical characteristics of the sediment particles (such as hardness, size and angularity).

Newcombe and Jensen (1996) based their SEV scores on suspended sediment concentrations expressed as the unit weight of sediment per unit volume of water, while in the proposed action, water quality criteria for suspended sediment are expressed as turbidity measured in NTUs.

Box 1. Severity of ill effects scores.

SEV	Description of Effect
	Nill Effect
0	No behavioral effects
	Behavioral effects
1	Alarm reaction
2	Abandonment of cover
3	Avoidance response
	Sublethal effects
4	Short-term reduction in feeding rates and feeding success;
5	Minor physiological stress: Increased rate of coughing; increased respiration rate
6	Moderate physiological stress
7	Moderate habitat degradation; impaired homing
8	Indications of major physiological stress: long-term reduction in feeding rate; long-term reduction in feeding success; poor condition
	Lethal and Paralethal Effects
9	Reduced growth rate; delayed hatching; reduced fish density
≥10	Increasing rates of mortality

Turbidity is a measure of how much a beam of light is scattered by particles suspended in water, and for any given particle type, there is a relationship between particle concentration and the amount of light scattering; therefore, turbidity measurements can be used to estimate suspended sediment concentrations or vice versa. For Snake River sediments, Schroeder (2014) determined the ratio of suspended sediment concentrations (mg/l) to turbidity (NTU) to be 2.4 mg/l per NTU. To develop SEV scores based on turbidity, numbers from Newcombe and Jensen (1996) are converted to turbidity units so the units of measure in this analysis are consistent with the units the Corps uses for monitoring suspended sediment.

In this opinion, SEV 6 is used to represent an approximate threshold where suspended sediment might harm juvenile or adult salmon and steelhead by causing moderate physiological stress, and SEV 10 represents an approximate threshold where fish might be killed (Box 1). In Figure 11, the severity scores of SEV 6 (broken line) and SEV 10 (solid line) are plotted to characterize the effects of suspended sediment on salmon and steelhead over a wide range of turbidity levels and exposure durations. The lower, dotted portion of the broken line represents circumstances where salmonids can often tolerate low levels of turbidity and the responses of fish vary in this range.

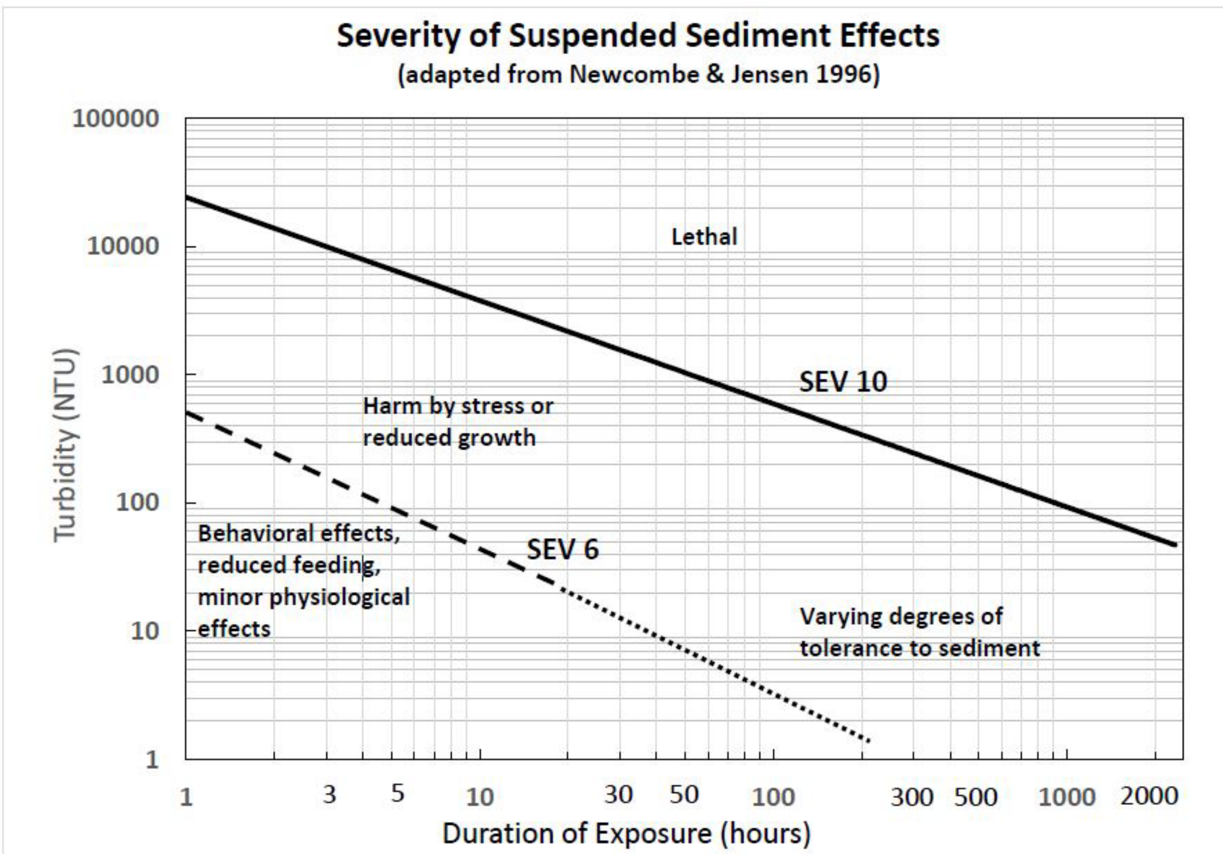

Figure 11. Relationship of turbidity, duration of exposure, and severity of effects. Adapted from Newcombe and Jensen (1996).

The highest turbidity observed at previous dredging sites 300 feet or more downstream from the dredge was 29 NTU over background (total of 34 NTU when added to average background turbidity) for several hours (Schroeder 2014). Using Figure 11, it can be seen that 34 NTUs would be unlikely to harm fish with exposures less than 10 hours. In addition to the index developed by Newcomb and Jensen (1996) NMFS reviewed available data including experiments with effects of turbidity on fish. The lowest turbidity level found by NMFS that demonstrated sublethal harm is found in Sigler et al. (1984), where they observed a reduction in growth of newly-emerged steelhead and coho salmon when exposed to constant turbidity of 25 NTU for 14 days. With the required turbidity standard of no more than 5 NTU over background, and background turbidity typically less than 5 NTU, turbidity will typically be less than 10 NTU throughout most of the turbidity plumes below dredge sites. Exposure to 10 NTUs would not cause harm at durations less than roughly 50 hours (Figure 11). Turbidity from dredging and disposal may exist 24 hours per day throughout the entire 76-day work window (1,848 hours), which is a sufficient duration to cause harm if fish did not move to avoid the turbidity, but lethal effects would not occur at levels allowed by the state of Washington standards or with levels of turbidity observed in previous dredging efforts.

Any fish that remain in the turbidity plume for more than a day or two are likely to be harmed by suspended sediment; however, at 300 feet or more from the dredge suspended sediment concentrations are low enough that adverse effects on fish are not anticipated even with extended exposure. Extended exposure and adverse effects on some fish within the first 300 feet of the plume may occur; however, other fish initially exposed to plumes will likely move out into adjacent non-turbid areas of the Snake and Clearwater Rivers. Bisson and Bilby (1982) found that juvenile coho salmon typically exhibited avoidance behavior at the outset of exposure to increased turbidity, but among the fish that did not initially move away from turbidity, an increasing proportion of fish moved out of turbid water as turbidity increased.

During the past efforts to create the shallow water bench near Knoxway Canyon during in-water disposal of dredged material, turbidity was much higher than the dredge sites and it remained high for longer durations. Dixon Marine Services (2006) attributed the exceedances at the disposal site to the deposited sediment sliding down the slope. The dimensions of the disposal area have been widened in this proposed action to decrease the likelihood of sliding material (sliding sediment is not an issue at the dredge sites). Operations in 2005 had to cease at the disposal site for more than 10 hours because of elevated turbidity. The threshold for this operation was raised to 75 NTU in order to complete the project. For the 2022/23 proposed action, however, sliding and associated high turbidities are not anticipated. The Bishop's Bar in-river disposal site is relatively flat and will be built upon a base layer of coarser materials from the Ice Harbor dredge spoils. The proposed action is not attempting to create a shallow water bench, and will not have the associated steeper sloped margin into deeper water that generated the sliding/slumping at the Knoxway site in 2005 and 2015.

Worst-case and typical turbidity levels from dredging (Figure 12) were developed by Schroeder (2014) based monitoring data from the 2005 dredging and modeling. The yellow line on the graph at 25 NTU represents the approximate threshold where fish might be harmed if they remained in the sediment plume for more than 1 day. The graph shows that under typical circumstances, dredging is unlikely to harm fish in the sediment plume for a duration less than 24 hours at any distance from the dredge, while under the worst case, harm might occur in the first 300 feet with a 24-hour exposure. Under the worst case, continuous exposure to the sediment plume beyond 24 hours could cause a reduction in feeding or physiological stress in adults or juveniles. However, initial exposure to turbidity is likely to cause some fish to abandon areas with high suspended sediment concentrations, and thus avoid prolonged exposure adverse effects of sediment other than forcing fish to move. The energetic cost of moving away from the turbidity plume should be low because similar suitable habitat is available nearby.

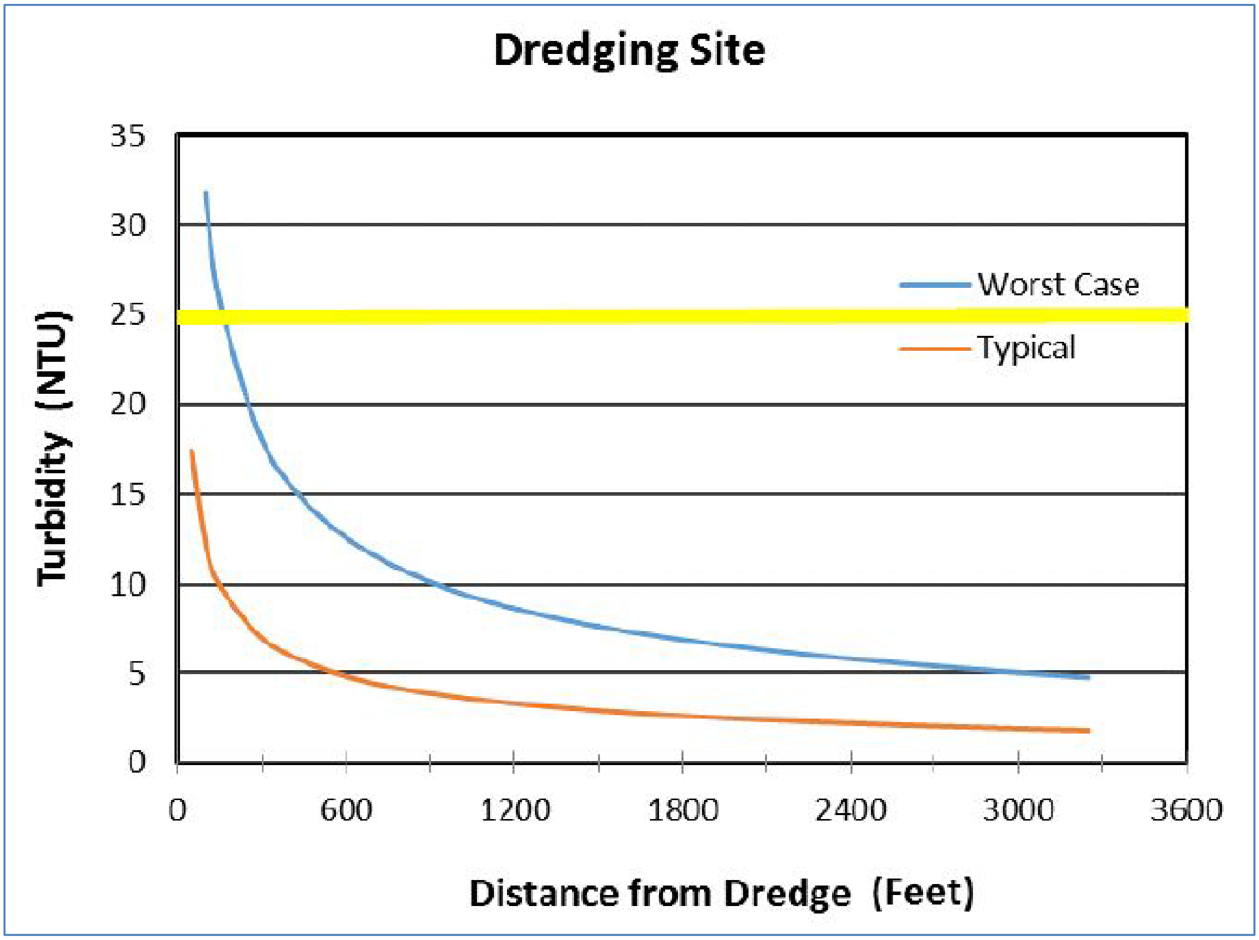

Figure 12. Modeled turbidity predictions (from Schroeder 2014).

The number of juvenile fishes likely to be exposed to potentially-harmful turbidity from the proposed action can be estimated from fish densities and the size of the area where suspended sediment will exceed 25 NTU. The 25 NTU threshold in Figure 12 from Schroeder (2014) is based in part on the findings of Sigler *et al*. (1984), where they observed a reduction in growth of newly-emerged steelhead and coho salmon exposed to constant turbidity of 25 NTU for 14 days. As shown in Figure 12, under typical circumstances, fish would not be harmed by sediment from dredging, but under the worst-case circumstances, potentially-harmful sediment concentrations may occur within roughly 300 feet downstream from the dredge. The area of individual dredge plumes where turbidity may be 25 NTU is 135,000 feet^2 (450 feet wide x 300 long) based on extrapolation of the modeling results from Schroeder (2014). The total area for the disposal site is 1,020,000 feet^2 (1,700 feet long x 600 feet wide). The total area of the dredge sites is approximately 25 acres, or 910,575 feet^2 (101,175 m^2).

The total area where turbidity plumes will occur is larger than the dredged and disposal areas per se. Applying the dimensions of 300-foot length and 450-foot width for the portion of plumes where NTU may meet or exceed 25 NTU, NMFS estimated the dimensions of potential 25 NTU plume at the disposal site to be 2,000 feet long by 1,050 feet wide, or 2,100,000 square feet (233,333 m^2). To estimate plume area associated with the dredging, NMFS contacted the Corps for average dimensions of dredging (September 20, 2022 personal communication Ken Troyer, NMFS, with Ben Tice, Corps). The typical dredge area width of the channel will be 450 feet; and the estimated plumes of 25 NTU or more would essentially double this width, extending 225 feet outward on each margin of the dredging. There will also be some added area at the bottom edge of dredge sites where the potential 25 NTU plume extends 300 feet below the dredging. Considering these widths and lengths, NMFS' overall estimate for the plume area (25 NTU portion) associated with the dredging is 300,000 m^2. The combined area of these plumes from dredging and disposal is approximately 233,333 m^{2+} 300,000 $m^{2=}$ 533,333 m^2.

According to Tiffan and Connor (2012), the mean density of fall Chinook subyearlings at depths of 6.5 to 20 feet (similar to the depth where the dredging and fill will occur) is 0.002 fish per m^2. Based on the 533,333 m^2 area were turbidity may exceed 25 NTU (20 NTU over typical background level), and a fish density of 0.002 fish per m^2, this results in an estimate of 1,067 juvenile fall Chinook salmon that might be exposed to harmful amounts of suspended sediment if they fail to move out of the plume. The majority of these fish are likely to move out of the sediment plume when it is first encountered; therefore, few of these fish are likely to be harmed or injured by the suspended sediment. A small number of juvenile steelhead and spring/summer Chinook salmon may also occur in the sediment plumes, but these lifestages are generally not present or present in very low numbers during the work window. Based on information PIT-tag sampling, sockeye salmon are unlikely to be in the action area during the work window. Adult steelhead in the action area are even less likely to be exposed to harmful concentrations of suspended sediment than juveniles since the distance they need to move in order to avoid the sediment, in relation to their body length, is much shorter than the relative distance for juveniles, and therefore requires less effort to move. Adult steelhead are also likely to be in deeper waters that tend to be toward the opposite shore.

Effects to Fish from Exposure to Contaminants

Numerous chemical contaminants can be found in Snake River and Clearwater River sediments. The contaminants can become resuspended in the water column when sediments are excavated and deposited. Listed fish can potentially be exposed directly to chemicals that become resuspended in the water through dredging activities, or exposed indirectly through the consumption of contaminated prey that become dislodged from disturbed sediments. Effects have the potential to be long-term as contaminants cycle through the Clearwater and Snake Rivers and associated reservoir system.

The Corps collected sediment samples from the dredge prisms 2019 (USACE 2020) to determine the chemical content of sediments at the proposed dredging sites. Contaminant concentrations in the sediment were compared to the 2009 sediment criteria contained in the Sediment Evaluation Framework for the Pacific Northwest (SEF) and the Washington State Department of Ecology (WDOE) 2013 sediment management standards (SMS) to determine if contaminants exceed the criteria. The sediment samples were analyzed for grain size, total organic carbon, percent solids, TAL metals, PCBs (Arochlors), semi-volatile organic compounds, polycyclic aromatic hydrocarbons, total petroleum hydrocarbons (diesel-heavy oil range), halogenated pesticides, organophosphorus pesticides, organonitrogen pesticides, phenylurea pesticides, carbamate pesticides, glyphosate, and high-resolution dioxin/furan congeners. Elutriate samples (water filtered from a water/sediment mixture after thorough mixing) were also analyzed for some of the sites to evaluate the potential release of contaminants from disturbed sediments.

Out of the 37 chemicals analyzed in the 2019 sediment samples, the results showed concentrations of 4-methylphenol exceeding screening limits at the Port of Clarkston Crane Dock and Cruise Dock locations. The likelihood of injury would be influenced by a number of factors, including the volume of sediment released with concentrations above toxicity thresholds, the organic carbon content of those sediments, sediment dispersion patterns, and the hardness of the water into which the sediment was released.

Exposure to phenol or 4-methylphenol can have a wide range of lethal and sublethal toxic effects that vary with the duration of exposure and concentration of the contaminants (Tables 12 and 13). Fish that experience sublethal effects of contaminants may have increased vulnerability to predators or suffer from physical impairments that may reduce the fish's growth rate, reproductive success, or survival rate if the effects are persistent. Fish might also recover with little consequence when they are no longer exposed to contaminants.

Sediment Contaminant Modeling. The Corps conducted Suspended sediment fate (STFATE) and DREDGE modeling (Gidley and Schroeder 2014) to predict water column concentrations of phenol and 4-methylphenol from both dredging and disposal operations, based on conditions likely to occur in the action area and the contaminant concentrations found in the sediment samples. The results of the modeling indicated that phenol concentrations were several orders of magnitude below the lowest threshold in Table 9. Modeled concentrations of 4-methylphenol were compared to the 2.8 mg/L 4-day no observable effect concentration (Table 9. This threshold is the most relevant effects threshold for predicting toxic effects to listed salmon and steelhead from the proposed action: The 4-day duration of exposure is similar to what might be expected during dredging (rather than the value reported in Table 10 for a 27-day exposure); the value is based on the same fish genus as steelhead; and lower thresholds observed in hard water are not representative of the soft water conditions found in the action area.

The STFATE model was set to predict concentrations over distances from 150 feet to 3600 feet from the disposal activity. The worst-case scenario at the 150-feet point of compliance for disposal operations was based on 3000 cy discharge at low velocity (0.2 feet/sec) and high suspended solids (5290 mg/L) and resulted in 0.03 mg/L for 4-methylphenol and 0.02 mg/L for phenol, well below concentrations that may result in impacts. For dredging activity, the DREDGE model output for 0.8 feet/sec and total suspended solids of 62 mg/L (almost 10-fold greater than background) resulted in predicted concentrations at the 150-point feet of compliance of 0.00097 mg/L for 4-methylphenol and 0.000034 mg/L for phenol, again, well below concentrations that may result in impacts (Table 10). Consequently, adverse effects from exposure to phenol or 4-methylphenol in the water column are unlikely to occur. As an added precaution, the fine-grained sediments from the Port of Clarkston sites will be placed near the bottom of the disposal area, and the uppermost layer will be composed of sands from other sites to further reduce contaminant concentrations in the water column.

Table 9. Studies documenting the toxicity of water-borne phenols to salmonids.

Concen-tration (mg/L)	Species	Endpoint	**Source** (as cited in Johnson 2014)
11.7	Brown trout	24 hr LC50[1]	Miller and Ogilvie 1975
11	Brown trout fingerlings	7 day LC50	Lazorchak and Smith 2007
9	Rainbow trout	48 hr LC50	Swift 1975
6	Rainbow trout fingerlings	7 day LC 50	Lazorchak and Smith 2007
6	Brown trout fingerlings	7 day growth IC 25[2]	Lazorchak and Smith 2007
4	Rainbow trout fingerlings	7 day growth IC 25	Lazorchak and Smith 2007
1.1	Laval rainbow trout	LC50	DeGraeve *et al*. 1980
0.6	Rainbow trout	Changes in liver weight, liver cell morphology, plasma protein and albumen	Monfared and Salati 2013
0.3	Larval rainbow trout	growth	Hodson *et al*. 1984
0.2	Larval rainbow trout	growth	DeGraeve *et al*. 1980
0.12	Larval Rainbow trout	27 day LC 50	Milleman *et al*. 1984
0.19	Larval Rainbow trout	23 day LC50	Black *et al*. 1983
0.1	Rainbow trout eggs	Reduced hatching success in soft water	Birge 1979
0.1	Rainbow trout eggs and larvae	27 day LC 50 in soft water	Birge 1979
0.07	Rainbow trout eggs and larvae	27 day LC 50 in hard water	Birge 1979
0.05	Rainbow trout fingerlings	Changes in activity, ventilation rate, other behaviors	Kaiser *et al*. 1995
0.01	Rainbow trout eggs	Reduced hatching success in hard water	Birge 1979

[1] LC50 is the lethal dose at which 50% of the population is killed in a given period of time.
[2] IC25 (inhibition concentration) is the chemical concentration in water likely to cause a 25% reduction in the rate of survival, growth or reproduction.

Table 10. Studies documenting the toxicity of 4-methylphenol (p-cresol) to salmonids and other fish.

Concentration (mg/L)	Species	Endpoint	Source (as cited in Johnson 2014)
11.3	Raimbow trout	4-day LC100	Bergman and Anderson 1977
8.6	Rainbow Trout	4-day LC50	Bergman and Anderson 1977
7.9	Rainbow Trout	4-day LC50	Degraeve *et al.* 1980
7.4	Rainbow trout	4-day LC50	Hodson *et al.* 1984
5	Rainbow trout	2-day LC50	Shumway and Palensky 1973
3.82	Rainbow trout	6 hrs Physiological changes	McKim *et al.* 1985
3.36	Pink salmon	4-day LC50	Korn *et al.* 1985
3.0	Rainbow trout	2- days Liver enzyme changes	Dixon *et al.* 1987
2.8	Rainbow Trout	4-day NOEC[1] concentration for mortality	Bergman and Anderson 1977
0.12	Rainbow trout	Tainting of fish	Shumway and Parkening 1973
2.57	Fathead minnow	Growth 32 days	Barron and Adelman 1984
0.4	Fathead minnow	Biochemical changes (nucleic acid & protein) 4 days	Barron and Adelman 1984

[1] NOEC is the no observed effect concentration

Bioaccumulation Hazards. As noted in the environmental baseline section above, fish tissue sampling (including salmonids) showed uptake of contaminants, most notably in resident fish. Some of the studies indicated there is evidence of contaminant "body burdens" in some juvenile salmon and steelhead, potentially causing sublethal and lethal effects on some fish. However, with respect to this proposed action, both the CORPS sampling of this substrate material at these sites and the nature of this action tend to indicate the action will not increase these bioaccumulation effects occurring under the baseline.

Exposure to Oils and Greases. Use of dredge equipment and barges adjacent or within river channels poses the risk of an accidental spill of fuel, lubricants, hydraulic fluid, antifreeze, or similar contaminants into the riparian zone, or directly into the water. If ESA-listed species are exposed to these toxic substances, individuals may die or experience sublethal effects such as immunosuppression or reduced growth. In addition, a contaminant spill or leak into the water may indirectly affect ESA-listed species by reducing the quantity and/or quality of prey organisms (Bravo 2005; Bury 1972; Johnson et al. 2008; Meador et al. 2006; Neff 1985; and Staples et al. 2001).

It is possible that chemical contamination could occur during project implementation. Our analysis assumes that refueling of equipment may occur while the dredge equipment is in the water. As such, it is possible that fuel, lubricants, hydraulic fluid, antifreeze, or similar contaminants could be spilled into the riparian zone, or directly into the water. If this were to occur, fish present in the area could be killed or experience sublethal effects as a result of prolonged exposure to the contaminants.

Displacement and/or impingement of fish by dredge and disposal equipment and operations

Dredging and disposal operations create disturbances that could significantly disrupt normal behavior patterns in situations where a fish is incapable of moving to an area where they will not be affected by the disturbance. Since listed fish in the action area are all physically capable of avoiding the equipment, disturbances caused by noise, turbidity, and use of equipment in the water are likely to prompt fish to move away from dredging or disposal operations. When a fish moves to avoid project activities, it could be affected in several ways: there would be an energetic cost from the movement (Barton and Schreck 1987); juvenile fish may encounter increased vulnerability to predation (Frid and Dill 2002); and conditions in the new environment might be more or less favorable for growth and survival.

In a large river such as the Snake River, juvenile salmon displaced from dredging or disposal site can easily move laterally to avoid the disturbance from project operations. The effects of moving to a different area are likely to be benign in most instances since similar habitat occurs throughout the action area, and fish would not need to swim far to find similar habitat. A brief disruption from moving from one spot to another is unlikely to have any lasting effect due to energy expenditures or disruption in feeding. Carlson et al. (2001) found that fish displaced by dredging in the Columbia River resumed normal positions and normal behavior within a short time after moving. The observations by Carlson et al. (2001) indicate that fish are unlikely to incur significant energetic costs to avoid a dredge and find suitable habitat, and the physical characteristics of large rivers make it likely that fish can move to an area that does not meaningfully differ from their initial position. In the event that a juvenile fish falls prey to a predator as a result of displacement, such low numbers of all species are likely to be near each disturbance site such that any adverse effects that might occur from displacement or avoidance would not cause discernable population effects.

Dredging equipment can potentially injure or kill fish from trauma caused by entraining or scooping fish from the stream, or from moving machinery. The likelihood that fish will be killed or injured by dredge equipment depends on a variety of circumstances: the type of equipment used, the swimming abilities of the fish, and the likelihood that fish would be present at the dredge site. There are two types of dredges based on their mode of operation – hydraulic and mechanical. Dredging equipment that will be used in the proposed action is limited to mechanical dredges, which could be a dragline, clamshell bucket, or scoop. Mechanical dredges work by scooping materials from the bottom and lifting them out of the water with a boom or cable. Mechanical dredges do not have the capability to entrain fish since there is no tractive force to draw fish toward the dredge. Organisms with poor swimming ability can be scooped up by mechanical equipment. A considerable amount of splashing, noise, and movement of equipment in and out of water occurs each time a scoop or bucket is dropped into the water and pulled back to the surface. The disturbance caused by operating a mechanical dredge is likely to elicit a startle response in salmon or steelhead that are in the vicinity of the dredge and also discourage more distant fish from moving toward the dredge site. Suspended sediment created by the dredging is also likely to discourage fish from approaching the dredge equipment since the initial response of a fish to increased levels of suspended sediment that is described by Newcombe and Jensen (1996) is to move away from the source. A plume of suspended sediment would surround the dredge equipment and act as a deterrent to fish.

The chances of a listed fish encountering dredge equipment are reduced by the timing and location of the activities. The winter work window ensures that all listed salmon and steelhead in the action area would be large enough to have developed swimming abilities that enable them to avoid mechanical dredge equipment. At the proposed dredge sites, fish have ample room to avoid dredging activities since the river is substantially wider than the area affected by a dredge. The dredge sites are also located at depths that are unlikely to be frequented by listed fish during the work window. The dredging will occur in water less than 14 feet deep and recent studies indicate that in winter, both juvenile and adult salmon and steelhead prefer deeper waters (Tiffan and Connor 2012).

Effects to Redds. At the Ice Harbor dredge site, there is a possibility that one or more redds (SR fall Chinook salmon) might occur in the area to be dredged. The Corps has committed to thoroughly survey any areas proposed for dredging where SR fall Chinook redds might occur (i.e., near and within the Ice Harbor navigation lock approach) prior to dredging, and then dredge around or otherwise avoid any observed redds. Surveys are likely to detect fall Chinook redds, if present, but if a redd goes unnoticed, the entire redd could possibly be destroyed. In multiple redd surveys since 1993, no redds have been found within the navigation lock approaches of any of the lower Snake River dams (Dauble et al. 1999; Mueller 2009; Mueller and Coleman 2007; Mueller and Coleman 2008). The probability of a redd being present at the Ice Harbor site is low to begin with, and the redd surveys further reduce the possibility that a redd would be destroyed. Given these circumstances it is very unlikely a redd will be destroyed.

In view of the above factors, listed salmon or steelhead are unlikely to be injured or killed by the dredging equipment. There are numerous factors that discourage juvenile or adult fish from getting close enough to the dredge to risk injury, and redds are unlikely to be encountered due to the fact they have not been observed previously at the dredging sites and specific efforts to identify and avoid any redds before dredging make it even less likely they will be disturbed.

Death or Injury from In-water Sediment Disposal. Inwater disposal of dredge spoils can bury juvenile fish or expose them to extremely high concentrations of suspended sediment if materials descend too rapidly for the fish to escape. Past dumping of dredged material showed the material tended to fall to the river bottom in a clump rather than disperse. Clumped material falls rapidly and entrains water during descent. Fish and other aquatic organisms can be entrained in the sediment plume and become buried. Drabble (2012) investigated the potential for disposal of dredge materials to bury marine organisms, and found that organisms vulnerable to burial consisted primarily of those that live near the bottom or are incapable of making a rapid escape.

The same principle was also described by Nightengale and Simenstad (2001) who noted that juvenile white sturgeon in the Columbia River were susceptible to burial by in-water sediment disposal due to their small size, limited swimming ability, and tendency to physically rest on the stream bottom. Juvenile salmon and steelhead and adult steelhead that are present in winter do not have any of the characteristics that make fish vulnerable to burial. These life stages of salmon and steelhead have relatively high swimming speeds that enable them to rapidly escape when they are alarmed, and they do not rest on the stream bottom.

The timing of the proposed action and the habitat preferences of salmon and steelhead also make burial or injuries from in-water disposal unlikely. Very few SR fall Chinook salmon subyearlings use the proposed disposal site at Bishop Bar in the winter (Tiffan 2013; Tiffan and Connor 2012). By winter subyearling SR fall Chinook salmon and all other listed anadromous fish are large enough to have developed swimming abilities and habits that would enable them to escape from the disposal area before sediment could bury or injure them when they are in an unconfined area. If fish were located in depressions, near mounds of sediment, or other types of cover within in the disposal area, these physical features could act as barriers that prevent rapid escape. In nearly all circumstances fish would likely evade burial or injury when sediment is released at the disposal site, particularly after the initial load is dumped. The initial load of sediment is likely to disperse fish from the disposal site. However, if fish are in a confined area directly below the barge when opens up to dump sediment, some fish may be buried or injured by the disposal. Adult fish are unlikely to be buried or injured by disposal since they occupy deeper, central portions of the channel.

Effects to fish from effects to prey caused by substrate disturbance

The proposed action is likely to affect feeding behavior and food availability. Feeding behavior will be affected by reduced visibility in areas where turbidity is elevated by the proposed action and availability of benthic prey species is likely to be reduced where the riverbed is altered by dredging and disposal activities.

Feeding behavior would be altered by reduced visibility if fish were to remain in turbid areas. Juvenile steelhead and coho salmon have shown decreased growth rates when reared under chronically-turbid water in artificial streams as a result of decreased food consumption (Newcombe and MacDonald 1991; Sigler et al. 1984). In natural environments, salmonids typically avoid turbid waters when possible (Bisson and Bilby 1982; Sigler et al 1984; Berg and Northcote 1985). Since most fish are likely to avoid turbidity by moving out of the plume, effects of turbidity on feeding behavior are likely to be avoided by the majority of fish that encounter turbidity. However, some fish may remain in the turbidity plume. Since salmonids rely at least partly on vision to capture prey, turbidity can decrease their ability to locate and capture prey (Barrett et al. 1992; Vineyard and O'Brien 1976), although examples exist where feeding rates are not reduced by turbidity (e.g. Rowe et al. 2003; Gregory and Northcote 1993).

There are also environments in the Pacific Northwest where salmonids thrive in naturally-turbid waters as an apparent result of reduced predation on juvenile salmonids (Gregory 1993). Turbidity appears to act as a form of protective cover for juvenile salmonids (Gregory 1993). Turbidity that is used as cover may provide an advantage to planktivorous fish such as subyearling Chinook salmon when avian or piscivorous predators are present. In some situations, turbidity may be high enough to reduce predation risk without causing substantial decrease in their ability to capture zooplankton (DeRobertis et al. 2003). Given the various ways fish might respond to turbidity, the effects on individuals may be advantageous, neutral, or disadvantageous, but the majority of fish are likely to avoid turbidity and thus be largely unaffected by turbidity.

Feeding may also be affected by the physical disturbance of the riverbed. As discussed previously, the proposed action is likely to alter local populations of benthic invertebrates by crushing, covering, or dislodging them during dredging and filling activities. The availability of benthic invertebrate prey will be reduced in disturbed areas. While we know that planktonic species tend to be dominant prey items (Rondorf et al. 1990), we do not have a good understanding of the role of benthic prey in the diet on juvenile salmon and steelhead. We do not expect the availability of planktonic invertebrates to be affected by disturbance of the substrate; therefore, the principle food source will not be changed by disturbance of the riverbed. However, it is possible that the temporary reduction in benthic prey will affect the growth of a few juvenile fish rearing in the action area during dredging activities.

The impacts of changes in the prey base and feeding behavior are also minimized by the winter work window. Salmonids in northern latitudes typically experience a period of time in winter when feeding and growth are limited by low food availability, or by cold temperatures or short photoperiods that prevent fish from taking full advantage of available food (Triebenbach et al. 2009). This period of restricted winter feeding is typically is followed by a period of elevated growth rates and rapid restoration of lost energy reserves in the spring (Triebenbach et al. 2009). This phenomenon is described by Ali et al (2003) as "compensatory growth," and it has been demonstrated in laboratory experiments on sockeye salmon (Bilton and Robins 1973), Chinook salmon (Hopkins and Unwin 1997), rainbow trout (e.g., Simpkins et al. 2003), and coho salmon (Griffioen and Narver 1974).

Considering the ways that the action might reduce availability of prey, and ways that salmon and steelhead might respond to turbidity or changes in prey, individual fish may be affected by the action in different ways. The majority of fish are likely to avoid changes in feeding by moving away from areas affected by the proposed action. Fish that do not move out of turbid areas may experience lower feeding rates during in-water work activities. While we expect impacts at the scale of individual fish, the consequences of altered food availability or altered feeding rates are unlikely to cause significant changes in the growth or survival of fish at the population scale due to the timing of the activity to coincide with low temperatures, low abundance, and a period when fish naturally consume very little food; and due to compensatory growth mechanisms, that mitigate effects of winter food deficits.

Effects to fish from barge operations

A portion of future barge operations in the action area is facilitated by the proposed action. Barge traffic can cause effects to direct effects to fish from accidental fuel spills (discussed above), boat strikes, and wake stranding, and effects that reduce the quantity and quality of habitat available to fish.

Stranding and erosion from wave action. Wakes from large, deep-draft ships are known to strand juvenile Chinook along the shoreline, but smaller vessels such as barges that operate in water less than 14 feet (such as the Snake River navigation channel) do not create wakes large enough to strand fish (Pearson and Skalski 2011). Ships that are capable of generating wakes that strand fish require a draft deeper than the 14-foot depth of the Snake River navigation channel.

Boat Strikes. Boat strikes also appear to be unlikely. Xie et al. (2008) observed avoidance reactions of migrating adult sockeye salmon when the motor boat and fish were separated by a distance less than 7 m, but saw no reaction beyond this distance. Since moving vessels trigger an avoidance reaction in salmon and steelhead before the vessel reaches the fish, they are unlikely to be injured or killed from vessel strikes. All lifestages of listed anadromous fish in the Snake River are capable of avoiding vessel strikes since they have high burst speeds and they tend to avoid residing near the surface of the deeper water that barges use to navigate the channel.

Shade. When barges are moored at ports, they create the effect of a floating island that blocks sunlight underneath and alters currents near the surface. Subyearling Chinook salmon and other species swimming near the shore may encounter predatory fish that hide in the shadow of moored vessels. A variety of studies have found that predatory fish gain an advantage over their prey by hiding near overhead cover that creates low light conditions. As light levels decrease, predation on juvenile salmonids by piscivorous fishes may increase due to a diminished ability for the juvenile salmonids to detect predators (Rondorf et al 2010). The most significant piscivores in the action area that prey on salmon and steelhead are northern pikeminow and smallmouth bass, and to a lesser extent, walleye (Rieman et al. 1991). Northern pikeminow and smallmouth bass may sometimes use shade to avoid detection by their prey (Chapman 2007). Smallmouth bass in particular have a strong affinity to in-water structures such as docks and piers and they are common predators of subyearling salmonids in the Columbia River drainage (Carrasquero 2001). However, barges lack the physical habitat complexity that provides hiding places found among the pilings that often support in-water structures so the effects of moored barges may not be comparable to effects of structures such as piers and docks.

Although predatory fish may use overhead cover from barges to prey on listed fish, moored barges in the action area are unlikely to offer much advantage to predators for several reasons: the sporadic mooring of vessels would not provide a consistent or predictable environment that would enable predatory fish to congregate at the ports; salmon smolts generally tend to avoid shaded areas and shorelines (Kemp et al. 2005); and migrating smolt lifestages by the time they reach Lower Granite reservoir favor deep, mid-channel areas (Rondorf et al. 2010; Chapman 2007). Given the above circumstances, moored barges are unlikely to substantially increase risks of predation on juvenile salmon or steelhead; however, the moored barges in this area may result in the predation of a few individual juvenile salmon and steelhead.

Injury to fish from exposure to electrical current from the lamprey sampling

The Corps proposes to monitor for the presence of larval Pacific lamprey (*Entosphenus tridentatus*) in areas to be dredged using a deep-water electroshocking platform (DEP) near the confluence of the Snake and Clearwater Rivers near Clarkston, WA (Appendix A). Incidental observations of freshwater mussels will also be recorded. The DEP system consists of a weighted diving sled coupled with a shocking system, optical camera, recording system and paired red lasers (class 3, 5 mW) for scaling and measurements. The DEP was designed to shock and film a riverbed area of approximately 0.5 m^2 during ideal conditions. Two high-resolution monitors for real-time viewing of the video are employed in conjunction with the recorder. An area of approximately 3003 ft^2 will be sampled in quadrats across the action area.

Sampling will occur on the riverbed prior to the dredging in-water work window. The anticipated shocking setting will be 150 volts DC, 45 mA, 4 Hz, 25% duty cycle and a 3:1 burst pulse rate, based on NMFS (2000) guidelines. At each location, the sampling sled will be lowered to near the substrate and shocking will be begin. Each shocking event is expected to last from 30-60 sec depending on the substrate composition. Few ESA-listed species are likely to be present in the action area during this time and any fish present are likely be deterred by the presence of the device operating near the river bed. If any juvenile salmonids are observed at a planned sampling location, the contractor will not conduct any shocking and will immediately turn the system off.

Injuries attributable to electroshocking can include hemorrhage, spinal fracture, and death; and stress-related phenomena such as impaired reproductive success or lowered resistance to disease. The DEP system uses voltage and amperage levels significantly less than typical backpack electroshocking equipment. Densities of juvenile Chinook salmon are expected to be very low during the time of the proposed sampling. Consequently, the effects of the DEP system electroshocking associated with the Pacific lamprey sampling are unlikely to harm or injure ESA-listed fish.

Effects to Critical Habitat

The proposed action will impact the following PBFs of juvenile rearing (SR fall Chinook salmon and steelhead), spawning (SR fall Chinook salmon) and adult/juvenile migration corridors (SRSS and SR fall Chinook salmon, sockeye salmon, and steelhead): (1) water quality; (2) food/forage; (3) cover/shelter; (4) substrate; (5) safe passage, and (6) floodplain connectivity.

Water Quality

The Project could negatively affect water quality PBF through short-term increases in turbidity (during dredging and disposal) or chemical contamination (accidental spill of oil or grease during dredging and barge operation). The turbidity plumes will be temporary, lasting only as long as in-water dredging and disposal is occurring.

All sediments proposed for dredging have been screened for the presence of contaminants at each of the dredging sites for suitability for in-water disposal. The screening procedures look for the presence of 37 chemicals of concern that have been identified in sediments found in rivers in the Pacific Northwest (USACE *et al*. 2013, 2020). These chemicals may be toxic to humans or aquatic organisms at certain concentrations. Sampling of the dredge prism in 2019 showed elevated concentrations of 4-methylphenol that exceeded screening levels in two locations. Samples at these locations underwent bioassay testing which met acceptability criteria as defined by the Sediment Management Standards, Chapter 173-204 WAC for the macroinvertebrate organisms tested. Thus, the proposed will not reduce the water quality PBF through contaminated sediments.

It is possible that chemical contamination could occur during project implementation and barge operation from an accidental leak or spill. Although the risk of a spill or that contamination will occur on any given project is low, it cannot be discounted. Thus, it possible that an accidental spill could result in a temporary degradation of the water quality PBF.

Food/Forage

The proposed action will have a short-term effect on benthic invertebrates by crushing, covering, or dislodging them during dredging and disposal activities (Harvey 1986; Harvey and Lisle

1998). The alteration of the riverbed will cause localized reductions in invertebrate populations found in the sediment and on the sediment surface (benthic invertebrates). The reductions are likely to be short-lived as disturbed areas are likely to be recolonized within several months after project completion (Fowler 2004; Yount and Nemi 1990; Griffith and Andrews 1981; Harvey 1986; Harvey and Lisle 1998). In a pre- and post-dredging study of dredge effects on benthic invertebrates and sediment characteristics in the lower Columbia River (RM 43.2) by McCabe and Hinton (1996), clamshell dredging had no detectable effect on the standing crops of benthic invertebrates. Nevertheless, it is likely that there will be a small reduction in the quantity and quality of forage PBF at the scale of the action area.

Cover/shelter

The proposed action will not directly alter the availability of shelter in the action area. The proposed action will facilitate the use of barges into the future in the action area. When barges are moored at ports, they create the effect of a floating island that blocks sunlight underneath and alters currents near the surface. This effect is discussed above in the Effects to Species. We concluded that although there is a reduction in the cover PBF in the action area, it is unlikely to substantially increase risks of predation on juvenile salmon or steelhead. Thus, we do not expect to see a reduction of the conservation value of this PBF.

Substrate

Dredging will disturb up to 48 acres of river bottom, primarily in the Federal navigation channel at the confluence of the Snake and Clearwater Rivers, and sediment disposal will disturb approximately 23 acres. The primary effects of the proposed action on the substrate are dislodging benthic invertebrates and moving sediment from dredge locations to the disposal sites. The dredging will not substantially change the substrate size composition since the sediments after dredging will be similar to the size of materials that existed before dredging.

None of the dredging or fill activities will occur in areas where substrates are suitable for spawning, except for the navigation lock dredge site at Ice Harbor Dam. At the navigation lock, the uppermost layers of the gravel build-up will be removed, while leaving similarly-sized deposits in place. The suitability of the navigation lock entrance for spawning would not be changed by dredging since the dredging will not occur in a location that is known to be used for spawning, and the dredged area would retain gravels that are similar to the materials removed by the dredging. If redds are present in an area where they might be affected by dredging, the dredging would not proceed until it could be done in a time or manner that does not adversely affect the redds. Substrate will likely return to pre-project conditions as fine sediments are flushed downstream during the first high flows after project completion; and the project will not reduce the conservation value of the substrate PBF within the action area.

Safe Passage

The effects of the proposed action on the safe passage PBF are likely to be inconsequential. Sediment plumes and noise disturbance from dredging and filling are likely to briefly disrupt moving fish that encounter these operations, and force fish to swim around the areas disturbed by turbidity or noise. Fish that encounter disruptions generally return to their normal behavior soon after encountering a dredge or sediment plume (ENCORP 2009). All of the ESA-listed Snake River species considered in this opinion migrate through the area as adults and juveniles. The work window is December 15 to March 1; a few months after 95% of all outmigrating juveniles have passed downstream into the Columbia River. Both adult and juvenile salmon and steelhead would be capable of moving through the action area at all times since dredging activities and turbidity do not span the entire channel all at once, and migrating fish prefer deep waters that tend to be on the opposite side of the river from depositional areas where dredging occurs. A similar argument applies when analyzing the effects of predation on safe passage (see discussion under 2.5 for the discussion of the cover PBF). Moored barges may create some areas of increased risk of predation for juvenile salmon and steelhead; however, these areas are situated away from where the fish migrate. We do not expect that ambush predators hiding under barges will meaningfully reduce the conservation value of safe passage because of the transient nature of barges, their small footprint, and types of locations within the action area. Thus, we do not expect the proposed action will reduce the conservation value of the safe passage PBF in the action area.

Floodplain Connectivity

Dredging can destabilize river banks and cause erosion, and may reduce the connection between rivers and their floodplains. The action area has been simplified from past dredging activities, with a disconnection from the floodplain in many reaches. We expect the proposed dredging activities will continue this effect at the scale of the action area with a reduction in the floodplain connectivity PBF.

2.6. Cumulative Effects

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

Some continuing non-Federal activities are reasonably certain to contribute to climate effects within the action area. However, it is difficult if not impossible to distinguish between the action area's future environmental conditions caused by global climate change that are properly part of the environmental baseline versus cumulative effects. Therefore, all relevant future climate-related environmental conditions in the action area are described earlier in the discussion of environmental baseline (Section 2.4).

In a large river such as the lower Snake River, habitat conditions in the action area are influenced by many activities that have the potential to affect streamflows or water quality in the action area, but occur upstream, outside the action area. Effects of future urban growth, forestry activities, sediment caused by agricultural practices, and flow reductions from water withdrawals are among the most significant activities that are likely to affect fish and critical habitat in the action area. These activities will continue to affect listed fish and critical habitat in the action area in a similar manner as described previously in the environmental baseline.

Within the action area, there is a significant demand within the state of Washington to begin appropriating water directly from the Snake River and from local aquifers that may be hydraulically connected to the Snake River. Furthermore, the state reopened the mainstem Columbia and Snake Rivers for further appropriation in 2002, after withdrawing the water from further appropriation in 1995. It is difficult to predict long-term trends in water quantity and quality, but impacts from water withdrawals are reasonably certain to continue.

Salmon recovery efforts in the action area have assisted with numerous projects to improve habitat for listed species. Ongoing studies and habitat enhancement projects conducted by the Snake River Salmon Recovery Board and Washington State Department of Fish and Wildlife Department to implement watershed plans and recovery plans are expected to continue.

Washington, Oregon, and Idaho have all developed total maximum daily load restrictions for various water quality components, turbidity, temperature, pesticides, heavy metals and others in the Snake River and some of its tributaries. As these plans are carried out water quality may improve.

The Snake River basin is one of many areas in the state of Washington that is experiencing ongoing wind power developments and expansion of transportation infrastructure. Recent national economic developments have slowed population growth in the last few years but non-agriculture employment has increased and that trend is likely to continue. Population changes and economic diversification is likely to result in greater overall and localized demands for electricity, water, and buildable land in the action area; affect water quality directly and indirectly; and increase the need for transportation, communication, and other infrastructure. These economic and population demands will probably affect habitat features such as water quality and quantity, which are important to the survival and recovery of the listed species. Unless planning includes measures to avoid, minimize, and effectively mitigate the potential effects to listed species, the effect of continued growth and economic diversification will likely be negative.

Sediment-producing actions such as on-going agriculture and forestry activities are likely to continue. Actions to reduce erosion from roads and agricultural lands are likely to occur at the same time actions that increase erosion are undertaken. No distinct trend in future sediment-producing activities can be predicted. An analysis of sediment sources in the Northern Rocky Mountains by Goode et al. (2012) and Clark et al. (2013) shows that any likely effect of new non-federal actions that increase or decrease sediment production will be vastly overwhelmed by agricultural inputs and natural sediment-producing events such as debris flows and wildfires. With the majority of the contributing watershed area being composed of forests where wildfires are a natural event (and likely to increase with climate change) and a major source of sediment in the lower Snake River, high sediment loads are likely to continue well into the foreseeable future.

2.7. Integration and Synthesis

The Integration and Synthesis section is the final step assessing the risk that the proposed action poses to species and critical habitat. In this section, we add the effects of the action (Section 2.5) to the environmental baseline (Section 2.4) and the cumulative effects (Section 2.6), taking into account the status of the species and critical habitat (Section 2.2), to formulate the agency's biological opinion as to whether the proposed action is likely to: (1) reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing its numbers, reproduction, or distribution; or (2) appreciably diminish the value of designated or proposed critical habitat as a whole for the conservation of the species.

Species

Snake River spring/summer Chinook salmon are at a moderate-to-high risk of extinction. While there have been improvements in abundance/productivity in several populations since the time of listing, the majority of populations, including those that could be impacted by the Project experienced sharp declines in abundance in recent years. Snake River Basin steelhead continue to be at a moderate risk of extinction within the next 100 years. The recent, sharp declines in abundance of both SRSS Chinook salmon and SRB steelhead are of concern and are expected to negatively affect productivity in the coming years. The Snake River salmon sockeye ESU is at a high risk of extinction within the next 100 years. All populations of these three species are at high risk of extinction and remain below recovery plan abundance and productivity targets. While the single population of SR fall Chinook is currently considered to be viable, it is not meeting its recovery goals. This is due to: (1) low population productivity; (2) uncertainty about whether the elevated natural-origin abundance can be sustained over the long term; and (3) high levels of hatchery-origin spawners in natural spawning area.

Threats to achieving the necessary increases in productivity and abundance include: tributary and mainstem habitat loss, alteration, and degradation; predation; disease; and climate change. Chinook salmon and steelhead also experience threats from harvest and hatchery practices. Restoration actions that are needed to support recovery of all three anadromous species considered in this opinion include restoration of perennial tributary connections with the Salmon River, provision of thermal refugia for migrating and rearing fish, and maintaining or restoring floodplain connectivity and riparian processes. Improving the quantity and quality of key overwintering areas will also be needed to support salmon and steelhead recovery.

The environmental baseline incorporates effects of ongoing anthropogenic activities (e.g., development, road use, recreation, agriculture, and restoration) within and upstream of the action area. Currently, aquatic habitat conditions in the action area are poor, with no pools, undercut banks, and no large woody debris. The Snake River is impaired for temperature, dissolved oxygen, and pH. There is substantial concern about the future of the Snake River's thermal regime and capacity to support critical life stages of anadromous salmonids. Elevated water temperatures likely stem from other habitat limiting factors such as reduced instream flows, warmed irrigation returns, reduced floodplain connectivity, and simplified channel morphology. Climate change is likely to exacerbate several of these ongoing habitat issues, in particular increased summer temperatures and decreased summer flows. Cumulative effects from state and private actions in the action area are expected to continue into the future and are unlikely to be substantially more severe than they currently are.

The action area is used by migrating adult and juvenile SRSS Chinook salmon, SR fall Chinook salmon, SRB steelhead, and SR sockeye salmon. Juvenile Chinook salmon and steelhead may rear in the action area, and SR fall Chinook salmon may spawn in the action area. The Corps proposes to dredge at five locations in the Snake and Clearwater Rivers and deposit the dredged material in the Lower Granite reservoir (Snake River) during the in-water work window of 2022/2023 (December 15-March 1). The Corps also proposes to incorporate conservation measures that will reduce turbidity and the risk of fuel spills from equipment.

In this opinion, we considered the following potential effects of the action:

- Effects to fish from a reduction in water quality from increased suspended sediment;
- Effects to fish from increased exposure to contaminated sediments, leaks or spills of oils and greases from dredge equipment as well as from barge operations supported by the dredging;
- Displacement and/or impingement of fish by dredge and disposal equipment and operations;
- Effects to fish from effects to prey caused by substrate disturbance;
- Effects to fish from barge operations; and
- Potential for injury to fish from exposure to electrical current from the lamprey sampling.

Habitat that is marginally-suited for SR fall Chinook salmon spawning occurs in the vicinity of the dredging site at the Ice Harbor Dam locks. Dredging in a spawning area could destroy redds and kill all of the incubating eggs if no efforts are made to locate and avoid redds. Damage to redds is unlikely under the proposed action since the dredging does not occur in an area that is likely to be used for spawning, and the dredge site will be surveyed to determine if any redds are present. If redds are found, dredging would not proceed at the site if the redds would be adversely affected by the dredging.

The sediment plume associated with dredging is unlikely to harm fish in the sediment plume for a duration less than 24 hours at any distance from the dredge, while under the worst case, harm might occur in the first 300 feet with a 24-hour exposure. Under the worst case, continuous exposure to the sediment plume beyond 24 hours could cause a reduction in feeding or physiological stress in adults or juveniles. However, initial exposure to turbidity is likely to cause some fish to abandon areas with high suspended sediment concentrations, and thus avoid prolonged exposure adverse effects of sediment other than forcing fish to move. The energetic cost of moving away from the turbidity plume should be low because similar suitable habitat is available nearby.

We estimate that 1,067 juvenile SR fall Chinook salmon that might be exposed to harmful amounts of suspended sediment if they fail to move out of the plume. The majority of these fish will likely move out of the sediment plume when it is first encountered; therefore, few of these fish are likely to be harmed or injured by the suspended sediment. A small number of juvenile SRB steelhead and SRSS Chinook salmon may also occur in the sediment plumes, but these lifestages are generally not present or present in very low numbers during the work window. Sockeye salmon are unlikely to be in the action during the work window.

Our analysis assumes that refueling of equipment may occur while the dredge equipment is in the water. As such, it is possible that fuel, lubricants, hydraulic fluid, antifreeze, or similar contaminants could be spilled into the riparian zone, or directly into the water. If this were to occur, fish present in the area could be killed or experience sublethal effects as a result of prolonged exposure to the contaminants. Similarly, ongoing barge operations have the potential to have a fuel leak which may affect fish migrating through or rearing within the action area.

Dredging equipment can potentially injure or kill fish from trauma caused by entraining or scooping fish from the stream, or from moving machinery. The likelihood that fish will be killed or injured by dredge equipment depends on a variety of circumstances including the type of equipment used and the density or abundance of fish present. Based on our analysis of the proposed action we conclude that it is unlikely that fish will be injured or killed by the dredge equipment. We do conclude however, that if fish are in an area directly below the barge when opens up to dump sediment, some fish may be buried or injured by the disposal.

Other project activities are likely to cause effects at the scale of the individual fish. These include effects to prey resources and long-term barge operations that are facilitated by dredge operation.

Effects to individual fish may potentially affect the attributes associated with a VSP (i.e., abundance, productivity, spatial structure, and genetic diversity that support the species' ability to maintain itself naturally at a level to survive environmental stochasticity). Only a few fish are expected to be killed or harmed as a result of project implementation considering the duration of the in-water work and the likely low densities of fish in the action area. Given the low densities of juvenile fish that may occur in the action area during the work window, the quality of habitat in the action area, and the availability of habitat not influenced by the proposed action within the action area, very few individuals are expected to be killed or harmed as a result of the dredging and disposal activities and ongoing barge activities. Further, the impacts are expected to be spread across all the populations of each species. Thus, the number of fish anticipated to be impacted is too low to appreciably influence the abundance or productivity of populations that utilize the action area. Because the population VSP parameters are not expected to be appreciably influenced, the viability of the associated MPGs will not be altered by the proposed action.

When considering the status of the species, and adding in the environmental baseline and cumulative effects, implementation of the Project will not appreciably reduce the likelihood of survival and recovery of SRSS Chinook salmon, SR fall Chinook salmon, SRB steelhead, or SR sockeye salmon.

Critical Habitat

Critical habitat throughout much of the designation area for the four listed species considered in this opinion has been degraded by intensive agriculture; alteration of stream morphology (i.e., channel modifications and diking); riparian vegetation disturbance; wetland draining and conversion; livestock grazing; dredging; dam construction, operation, and maintenance; road construction and maintenance; logging; mining; and urbanization.

The action area is a migratory corridor for all of the listed salmon and steelhead in the Snake River basin, and is a rearing area for reservoir-type SR fall Chinook salmon. Current conditions within much of the mainstem Snake and Clearwater Rivers are degraded relative to historic conditions. Dams and their associated reservoirs have modified much of the mainstem habitat downstream of the Clearwater River confluence previously used by SR fall Chinook salmon for spawning and altered the functional capacity of the habitat for all rearing and migrating salmon and steelhead. Formerly complex habitat in the mainstem and lower tributaries of the Snake River have been reduced, for the most part, to single channels with reduced or disconnected floodplains, side channels or off-channel habitats. The existing habitat conditions within the action area are influenced by the impacts of both federal and non-federal land use activities within and upstream of the action area. Current levels of these activities are likely to continue into the future and are unlikely to be substantially more severe than they currently are.

The proposed action has the potential to affect water quality, food/forage, cover/shelter, substrate, safe passage and floodplain connectivity PBFs. Implementation of the proposed action will cause small, short-term adverse effects to the water quality PBF due to elevated turbidity. There is also a risk of chemical contamination, which could temporarily degrade the water quality and forage PBFs. Due to the small and short-lived nature of these effects, the conservation value of the water quality and forage PBFs in the action area will not be appreciably reduced. The proposed dredging activities will cause adverse effects to the floodplain connectivity PBF at a local scale. However, this small area of impact is not expected to appreciable reduce the overall conservation value of these PBFs at the designation scale.

When considering the status of the species, environmental baseline, effects of the action, and cumulative effects, NMFS concludes that implementation of this proposed action will not appreciably diminish the function or conservation value of designated critical habitat as a whole for the conservation of the species.

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 the cumulative effects, it is NMFS' biological opinion that the proposed action is not likely to jeopardize the continued existence of SRSS Chinook salmon, SR fall Chinook, SR sockeye salmon and SRB steelhead, or destroy or adversely modify its their designated critical habitat.

2.9. 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).

The Corps will:

1. Minimize turbidity during dredge and disposal activities.

2. Monitor turbidity to ensure that the minimization measures are meeting the objective of minimizing take and that incidental take exempted by this ITS is not exceeded.

2.10. 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). “Harass” if further defined by interim guidance as to “create the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns, which include but are not limited to, breeding, feeding, or sheltering.” “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.

2.10.1. Amount or Extent of Take

In the opinion, NMFS determined that incidental take would occur in several ways, some of those to three of the subject ESA-listed species and some to all four. For juvenile SR fall Chinook salmon, SRSS Chinook, and SRB steelhead incidental take would occur as follows:

1) Fish within 300 feet downstream of dredge and disposal activities that do not move out of the plumes may be harmed by exposure to the turbidity;
2) Some of the fish displaced by turbidity and/or equipment operations will be killed or injured by predators;
3) Some of the fish at the disposal site will be injured or killed by burial if they are directly beneath a barge that releases material and there is not sufficient time and egress space for the fish to escape;
4) Temporary reduction in abundance and distribution of invertebrate prey species caused by dredge and disposal activities will reduce feeding, reducing growth some individual overwintering juveniles; and
5) Some of the fish within the action area will be injured or killed by project operations fuel leakages and spills (particularly if fuel collects along shallow river margins).

For juvenile SR fall Chinook salmon, SRSS Chinook, SRB steelhead, and SR sockeye salmon, with the proposed action enabling continued barge operations, incidental take in the future after the dredging project would occur as follows:

1) Some of the fish in the action area will be harmed by barge operation-generated fuel leakages and spills; and

2) Some of the fish in the action area will be killed by predator fish using moored barges as overhead cover for hiding and ambush.

As described previously, using fish densities from Tiffan and Connor (2012) and the extent of sediment plumes observed in previous dredging and disposal efforts, the number of fish likely to encounter suspended sediment in potentially-harmful concentrations is estimated to be 1,067 subyearling fall Chinook salmon and much smaller numbers of juvenile steelhead and juvenile spring/summer Chinook salmon. The number of fish actually harmed by the exposure is likely to be a small percentage of the fish exposed to the sediment.

The number of fish harmed by the action cannot be measured or estimated since the number of fish in the vicinity of areas affected by sediment will vary continuously as fish move in and out of work areas throughout the period of operation, and only a portion of those fish occupying areas affected by sediment plumes or sediment dumped from barges are likely to be harmed. Furthermore, if fish are harmed, they are unlikely to exhibit any outwardly visible signs of harm since it would occur primarily from physiological stress or reduced feeding rates; therefore, take cannot be quantified directly. Similarly, for the other sources of take noted above (displacement-caused predation, reduction in prey/feeding, harm from fuel spills, moored barges-caused predation) these cannot be practicably verified and quantified, particularly in this large river setting. In situations where the amount of take cannot be quantified, NMFS develops an ecological surrogate. Turbidity is used as a surrogate for this action since it is the primary mechanism of incidental take, and the area affected by turbidity also encompasses locations where take might occur from burial by sediment disposal.

For the take associated with project-caused turbidity, fish displacement, fish burial, fuel leakage/spill, and temporary reduction in prey base, two main aspects of the project and its effects together serve as surrogates for the extent of these types of take: 1) the activity area footprint (area of dredging and in-water disposal) and 2) the associated turbidity. The spatial dimensions of the project activity and the associated turbidity are causally linked to these five types of adverse effects on the juvenile salmon and steelhead. Area of turbidity involves the area fish will be affected within or displaced from, area of dredging and disposal involves the area of effect to benthic prey and potential for burial of fish, and operation footprint involves the amount of in-water dredge and disposal equipment operations and the associated potential for fuel leakage and spills.

1) The area to be dredged is a total of 25 acres at the five specified sites. The disposal area is 1,700 feet by 600 feet, or 2,100,000 square feet. Adhering to these area sizes represents the extent of take exempted.

2(a) The turbidity is monitored continuously at each site and should remain within compliance levels at the 900-foot sampling stations as achieved in recent past dredging, with an overall compliance rate of at least 98%, and periods of non-compliance having an overall average of less than 10 NTU above compliance level; and

2(b) The turbidity plume at each of the dredging sites and the disposal will not exceed 50% of the total river width. Adhering to achieving these specified turbidity compliance levels and widths additionally represents the extent of take exempted.

For the take associated with the indirect effect of the action-project-perpetuated barge operations (leakage/spill, moored barges/predation) the dredged depth of the navigation channel serves as a surrogate. This should be an effective surrogate because this depth has to do with the size of vessels used and moored and extent of these sources of take. The size of the vessels is causally linked to amounts of fuel involved and risk/amount of spills, and to the physical dimensions of the overhead cover for predator fish under moored vessels.

3) The depth of the channel in the dredged areas determined through bathymetric surveys shall not exceed an average of 16.5 feet. Adhering to this depth additionally represents the extent of take exempted.

2.10.2. Effect of the Take

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

2.10.3. 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).

The Corps will:

1. Minimize turbidity during dredge and disposal activities.
2. Monitor turbidity to ensure that the minimization measures are meeting the objective of minimizing take and that incidental take exempted by this ITS is not exceeded.

2.10.4. 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 complies) 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 (minimize turbidity and likelihood of burial):
   a. The Corps will require barges to release dredged material at Bishop Bar in a manner that minimizes turbidity and likelihood of fish burial. The Corps (or their contractor)

will open the door to the barge such that the dredged material is released in a manner that balances minimizing turbidity with providing opportunity for fish to move out of the disposal area. Release the material as slowly as possible without exceeding the turbidity standard.

b. The Corps (or their contractor) will pause sediment-producing activities when turbidity levels measured 900 feet downstream from the dredge or disposal site exceed 5 NTU above background when background levels are 50 NTU or less, or when turbidity levels exceed 10% over background when background levels exceed 50 NTUs. They may resume activities once turbidity levels are below those standards.

c. The Corps (or their contractor) will minimize dredging and disposal activities in the dark to the greatest extent practicable to provide time for turbidity to return to background levels in the action area.

2. The following terms and conditions implement RPM 2 (monitor turbidity):

   a. The Corps will develop and implement a water quality monitoring program to determine compliance with turbidity criteria described in the 1(b) above and thresholds for incidental take.

      i. Turbidity will be measured at stations located 300 and 900 feet downstream from the work zone at the dredging or disposal site, and at background stations.

      ii. The Corps will visually monitor the turbidity plume twice daily during the first 3 days of operations at each of the dredging sites and the disposal site to confirm the plume does not exceed 50% of the total river width.

   b. The Corps will complete a final monitoring report after all activities are completed and submit it to NMFS within six months after project completion. All reports will be sent to National Marine Fisheries Service, Snake Basin Office, Attention Northern Snake Branch Chief, 800 E. Park Boulevard, Suite 220, Boise, Idaho 83712-7743.

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

2.11. 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).

NMFS is recommending that the Corps look for opportunities to remove riprap and plant native riparian vegetation in the lower Snake and lower Clearwater Rivers that will support juvenile shallow water rearing habitat.

2.12. Reinitiation of Consultation

This concludes formal consultation for the Snake River Channel Maintenance project.

Under 50 CFR 402.16(a): "Reinitiation of consultation is required and shall be requested by the Federal agency or by the Service where discretionary Federal agency involvement or control over the action has been retained or is authorized by law and: (1) If the amount or extent of taking specified in the incidental take statement is exceeded; (2) If new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not previously considered; (3) If 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 written concurrence; or (4) If a new species is listed or critical habitat designated that may be affected by the identified 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 (PFMC) and approved by the Secretary of Commerce.

3.1 Essential Fish Habitat Affected by the Project

The proposed action and action area are described in the BA and this letter. The project area includes habitat which has been designated as EFH for various life stages of Chinook salmon (*O. tshawytscha*) and coho salmon (*O. kisutch*).

The action area, as described in Section 2.3 of the above opinion, is also EFH for Chinook salmon and coho salmon (PFMC 2014). The PFMC designated the following five habitat types as habitat areas of particular concern (HAPCs) for salmon: complex channel and floodplain habitat, spawning habitat, thermal refugia, estuaries, and submerged aquatic vegetation (PFMC 2014). The proposed action may adversely affect the following HAPCs: complex channel and floodplain habitat and spawning habitat.

3.2 Adverse Effects on Essential Fish Habitat

Based on information provided in the BA and the analysis of effects presented in the ESA portion of this document, NMFS concludes that proposed action will adversely affect EFH designated for Chinook salmon and coho salmon because it will have negative effects on water quality and benthic communities. The proposed project will alter a total of 48 acres of river bottom altering benthic habitat and macroinvertebrate production in the short-term. The action will also temporarily impair water quality near the dredging equipment and the disposal site at Bishop Bar.

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

1. Temporary degradation of water quality (turbidity, contaminants) in the Snake River channel from construction activities.
2. The alteration of current substrate and benthic forage by dredge and fill actions.

3.3 Essential Fish Habitat Conservation Recommendations

NMFS determined that the following Conservation Recommendations are necessary to avoid, minimize, mitigate, or otherwise offset the impact of the proposed action on EFH.

1. The Corps will initiate or continue studies on the availability and fish use of shallow water habitat in Lower Granite Reservoir and in downstream reservoirs. Information of the distribution, connectivity and patch size of existing shallow water areas relative to seasonal flows and fish use will help determine if there are additional areas where shallow water habitat can be created and have the greatest benefit to salmonids.

Fully implementing this EFH Conservation Recommendation would protect, by avoiding or minimizing the adverse effects described in section 3.2, above, for Pacific Coast salmon.

3.4 Statutory Response Requirement

As required by section 305(b)(4)(B) of the MSA, the Corps must provide a detailed response in writing to NMFS within 30 days after receiving an EFH Conservation Recommendation. Such a response must be provided at least 10 days prior to final approval of the action if the response is inconsistent with any of NMFS' EFH Conservation Recommendations unless NMFS and the Federal agency have agreed to use alternative timeframes for the Federal agency response. The response must include a description of 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 Recommendation, the Federal agency must explain its reasons for not following the recommendation, 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 (DQA) 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. Other interested users could include the Nez Perce Tribe, citizens of cities of Clarkston, Washington and Lewiston, Idaho; Walla Walla, Garfield, Columbia, Whitman and Asotin Counties in Washington; Nez Perce County in Idaho and others interested in the conservation of SRSS Chinook salmon, SR sockeye, SRF Chinook salmon, and SRB steelhead. 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 adhere to conventional standards for style.

4.2. Integrity

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

4.3. Objectivity

Information Product Category: Natural Resource Plan

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

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

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

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

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6. APPENDIX A

Pacific Lamprey Sampling Protocol

PRELIMINARY PROPOSAL

Basic Information

Title

Larval lamprey Assessment Using a Deepwater Electroshocking Platform and Freshwater Mussel Survey at dredging locations near the mouth of the Clearwater River

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Date of Submission

August 2, 2022

Project Summary

A. Project Goal

We propose to use PNNL's Deepwater Electrofishing Platform (DEP) described by Mueller et al. (2012) to determine larval lamprey presence at proposed dredging locations near the confluence of the Snake and Clearwater rivers near Clarkston, WA in the fall of 2022.

B. Objectives(s)

1. Determine larval lamprey densities (fish/unit area) at dredging polygons
2. Determine relative size distributions of lamprey observed.
3. Note the presence of any mussels observed with the video system and attempt to collect mussels when beds are encountered with ponar dredge to determine species.

Project Description

C. Background

The Corps proposes to monitor for the presence of juvenile lamprey in areas to be dredged near the confluence of the Snake and Clearwater Rivers in Clarkston, Washington and Lewiston, Idaho (Figure 1). Incidental observations of freshwater mussels will also be recorded. The Corps would like to determine the potential for larval Pacific lamprey and freshwater mussels to be rearing in areas to be dredged. Adult lamprey translocations have been occurring for several years and existing lamprey data may not reflect the results of these translocation efforts. Because juvenile lamprey spend several years rearing in freshwater sediments (primarily fine sediment and organic matter), they could be vulnerable to dredging.

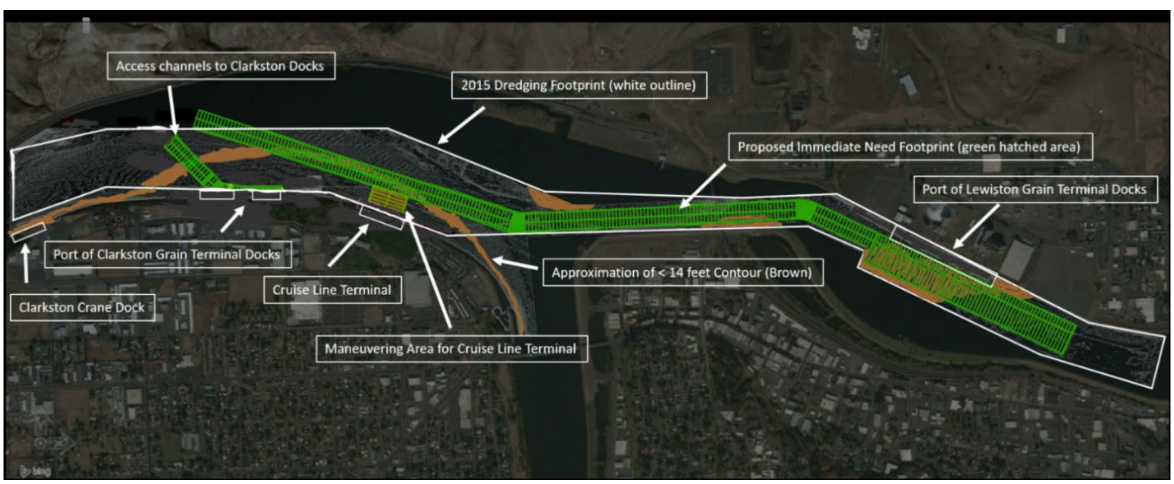

Figure 1. Proposed dredging regions outlined in green polygons. Main polygon includes the Clearwater River and downstream of the confluence, secondary polygon includes downstream portion in the Snake River.

The Walla Walla District of the U.S. Army Corps of Engineers (Corps) proposes to perform federal navigation channel maintenance dredging at two locations and ancillary/related port berthing maintenance dredging at two locations in the lower Snake River and lower Clearwater River in Washington and Idaho. The dredging would occur during the winter in-water work window, which is currently identified as December 15 through March 1. This action is consistent with the preferred alternative described in the Lower Snake River Programmatic Sediment Management Plan Final Environmental Impact Statement (PSMP EIS) (Corps 2014) and subsequent Lower Snake River Channel Maintenance Immediate Need Dredging for Commercial Navigation Environmental Assessment (Corps 2022) that is currently undergoing public review. The purpose of the federal channel maintenance activities is to re-establish the congressionally-authorized dimensions of the navigation channel. Dredging would occur in the federal navigation channel at the confluence of the Snake and Clearwater Rivers. The overall approach will include an evaluation of techniques, including PNNL's DEP, to sample for the presence of larval lampreys that may be inhabiting the dredging zones.

D. Methods

We propose to use PNNL's DEP to determine larval lamprey densities (fish/unit area) at the confluence of the Clearwater and Snake rivers in the fall of 2022.

Shocking System- The system consists of a weighted diving sled coupled with a shocking system, optical camera, recording system and paired red lasers (class 3, 5 mW) for scaling and measurements. The DEP was designed to shock and film a riverbed area of approximately 0.5 m^2 during ideal conditions. The DEP has been field tested and proven to be an extremely effective tool at determining presence/absence of larval lamprey with a sampling efficiency at 60% (Mueller et al. 2012, Arntzen et al. 2014, 2017). The DEP components included an aluminum frame with two 30 lb. lead torpedo weights, high-sensitivity remote camera (Sartek Model SDC-MAL) and paired red lasers (C-Map Systems model HL6312G). Lasers (red) will be used to determine sampling area and provide a calibrated reference to determine lamprey length data. An integrated video/tow cable attached to a manual winch with slip-ring mechanisms raises and lowers the platform to the desired depth. Recordings are made using a mini DV tape using a Sony DV HD portable recorder (model GV-HD700/1). Two high-resolution monitors for real-time viewing of the video are employed in conjunction with the recorder.

The shocking system utilizes a modified, ABP-2 backpack electroshocker unit (ETS Electrofishing, LLC) powered by a 12V deep cycle high amp hour battery with 16/2 gage conductors. Four electrodes are deployed in a rectangular pattern (25 cm apart on one side and 48 cm apart on the other side and extended to a length of 50 cm); (Figure 2). The anticipated shocking setting will be 150 VDC, 45 mA, 4 Hz, 25% duty cycle and a 3:1 burst pulse rate. At each location, the sampling sled will be lowered to near the substrate and shocking will be begin. Each shocking event is expected to last from 30-60 sec depending on the substrate composition.

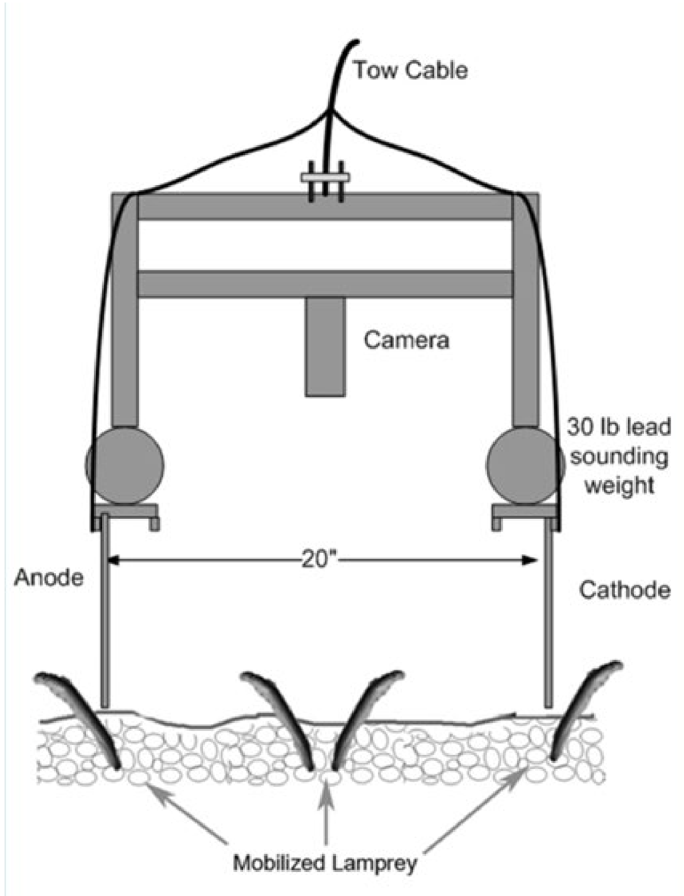

Figure 2. Lamprey presence/absence sampling approach illustrating the DEP and in-water system components.

An on-board, real-time differential global positioning system (DGPS) (Trimble Pathfinder® Pro XR) will be used to collect positional data and to navigate on preset transect grids during the surveys. The integrated DGPS beacon receiver and antenna provided DGPS corrections to calculate accuracy to below 0.5 m. The system software will display a background map of the study site on a personal computer so that researchers can navigate to site locations on a predetermined transect line and visually verify data accuracy in the field. Both the DGPS and video system will be synchronized via a time stamp. Field notes will be taken while the surveys were in progress, and video tapes will be further processed at the laboratory. Lamprey density will be calculated by using ratio of total numbers of lamprey observed by the calculated area for the sampling locations.

Lamprey habitat use will be evaluated while electrofishing each transect. If lamprey are observed, GPS coordinates and water depth will be recorded. Total depth will be obtained from the boat's sonar system. These data will provide the Corps with information regarding the presence/absence of lamprey at each of the sampling locations.

E. Study Design

The sampling protocol will consist of classifying a subset of each of two proposed dredging zones. Based on previous research in conducting deepwater sampling to determine lamprey presence and estimate density, the survey will be broken into 30 x 30 m (900 m^2) quadrats (Fodale et al. 2003). We will segregate these uniformly to achieve the 900 m^2 quadrats. Depending on the overall size of each survey zone, a minimum of 17 of these will be sampled to determine 80% accuracy in detection (Jolley et al. 2010). Transect spacing will be 15 m. A total of 9 sampling points within each of the quadrats will be randomly selected to survey with the DEP (Table 1). Since lamprey density in these regions is unknown, the sampling effort proposed should provide a quantitative estimate on overall densities.

Table 1. Proposed sampling effort within each of the polygons identified to be dredged.

Sampling Area	Total Area (m^2)	Total Quadrats	Quadrats to Sample	DEP Sampling Points
Main Polygon	404685	450	45	405
Secondary Polygon	28327	31	17	153
Total	433012	481	62	558

F. Facilities and Equipment

The following Equipment will be necessary for this study:

- PNNL research vessel, DEP system, GPS system.

G. Impacts

Clear and timely communication between the Pacific Northwest National Laboratory (PNNL) and USACE will be essential to minimize difficulties.

H. Biological Impacts

Note that Endangered Species Act (ESA) listed species and critical habitat in the action area for this project is described in the Corps' biological assessment (BA) for dredging that was previously submitted to NMFS and USFWS. Thus, that information is not repeated here. Note also that the DEP system was used by PNNL previously for a larval lamprey assessment in the Cowlitz River in western Washington with authorization from NMFS to the Corps (NMFS 2014, WCR-2014-034). A more recent study of substrate using electrical resistivity tomography (ERT) was conducted by PNNL in the Columbia River in southeastern Washington with authorization from NMFS and USFWS to the U.S. Department of Energy (DOE) (NMFS 2016, WCR-2016-5064; USFWS 2016, OlEWFW00-2016-1-1052). An evaluation of potential effects to salmonids from employing the DEP in this current larval assessment is provided below and draws on information from the above two consultations.

The most efficient transfer of electricity occurs between water and fish when fish and water conductivities match. In general, fish tissue has a standard conductivity of approximately 115 uS/cm (Miranda 2009) and wintertime water conductivity in the action area is about 300 uS/cm. These conductivities allow for moderate potential for transfer of electric current from water to fish.

Waveform, pulse rate (frequency), voltage, and current are the most important factors affecting potential fish immobilization/injury from electric current (Cooney pers. comm. 2016). NMFS (2000) provides guidelines for electrofishing in waters containing salmonids listed under the Endangered Species Act (ESA).

With regard to waveform, NMFS (2000) recommends the use of DC (direct current) or pulsed DC. With DC, electricity flows in only one direction creating an "attraction" towards the anode (Snyder 2003). With AC, electricity flow switches directions between anode and cathode, so there is not an "attractive" force. However, AC creates tetanizing electrical gradients across fish tissue that can result in spinal injury, hemorrhage, and death (Snyder 2003). Fish (especially salmonids) are generally more prone to immobilization and injury when exposed to AC rather than DC (Snyder 2003). The project will use DC, as indicated in Section D.

With regard to frequency, NMFS (2000) proposes DC frequencies of $\leq$30 Hz as the lower threshold (initial setting) for achieving immobilization. The project will use DC pulsed at 4 Hz (Section D), well below the 30 Hz level proposed by NMFS (2000).

With regard to current, the project proposes to deliver 45 mA, which is well below any electrofishing equipment. Boat electrofishers are generally operated at 1-10 amps. Backpack electrofishers are generally operated at 0.5-2 amps. Therefore, 0.045 amps (45 mA) is at least one order of magnitude lower than what would be used during a typical electrofishing operation.

With regard to voltage, the generally accepted electrofishing threshold for fish immobilization is 1 V/cm of DC (Cooney pers. comm. 2016). The electric field of the DEP was measured previously in a laboratory tank with a portable voltmeter (Mueller et al. 2012). Two wire leads from the voltmeter were positioned parallel to the electrical current flow to measure the voltage gradient. The specific conductance of the water in the tank was 202 µSiem. The shocker delivered a 30-s burst pulse (100 V, 4 Hz, 25% duty cycle and 3:1 burst rate). Voltage gradients ranged from 0 V/cm at the edge of the measured region to 0.92 V/cm near one of the electrodes. The average voltage gradient for the 4800 cm^2 area was 0.34 V/cm. For the lamprey larvae study the shocker voltage will be 150 VDC (see Section D) and the maximum and average voltage gradient is estimated to be about 1.4 V/cm and 0.5 V/cm, respectively, based on the 50 percent increase in voltage. Thus, the voltage, if considered alone (absent frequency and current), would be sufficient to cause immobilization only at the high end of the voltage field. However, given the low frequency and current settings (well below thresholds for immobilization), the use of 150 VDC would be unlikely to cause immobilization.

PNNL will also minimize any direct impacts to ESA-listed anadromous salmonids while conducting surveys and sampling activities. Pacific lamprey are currently not a ESA listed species. The work will be conducted between November 1 and December 14, 2022. PNNL is only able to effectively operate the system during relatively clear water conditions (4-5 NTU's or less), any fish are likely be deterred by the presence of the device operating near the river bed. If any juvenile salmonids are observed at a planned sampling location PNNL will not conduct any shocking and will immediately turn the system off. The primary operator, Robert Mueller, is experienced using the DEP and has completed a certified electrofishing course (BIO-407) from the Northwest Training Center.

I. Schedule

Task	End Date
Finalize Sampling Plan	August 15, 2022
Field Preparation	October 30, 2022
Conduct surveys	December 14, 2022
Preliminary Summary Findings	December 15, 2022
Final Report	February 28, 2023

Technology Transfer

Information acquired during the proposed work will be transferred in the form of a technical document.

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Budget

The budget will be submitted under separate cover.