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

Refer to NMFS No:
WCRO-2021-01886

May 16th, 2025

Calvin J. Terada
Division Director
U.S. Environmental Protection Agency, Region 10
1200 6th Avenue, Suite 155
Seattle, Washington 98101-2182

Re: Endangered Species Act Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response for the Programmatic Consultation on the Portland Harbor Superfund Site Cleanup Activities

Dear Mr. Terada:

Thank you for your August 2, 2021, letter 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 Programmatic Consultation on the Portland Harbor Superfund Site Cleanup Activities. Thank you also for your request for essential fish habitat (EFH) consultation. NMFS reviewed the proposed action for potential effects on EFH pursuant to section 305(b) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA), implementing regulations at 50 CFR 600.920, and agency guidance for use of the ESA consultation process to complete EFH consultation.

In this opinion, we concluded the proposed action is not likely to jeopardize the continued existence of the following species, or result in the destruction or adverse modification of their designated critical habitat:

1. Lower Columbia River (LCR) Chinook salmon (*Oncorhynchus tshawytscha*)
2. Upper Willamette River (UWR) Chinook salmon
3. Upper Columbia River (UCR) spring-run Chinook
4. Snake River (SR) spring/summer-run Chinook salmon
5. SR fall-run Chinook salmon
6. Columbia River (CR) chum salmon (*O. keta*)
7. LCR coho salmon (*O. kisutch*)
8. SR sockeye Salmon (*O. nerka*)
9. LCR steelhead (*O. mykiss*)
10. UWR steelhead
11. Middle Columbia River steelhead
12. UCR steelhead
13. Snake River Basin (SRB) steelhead
14. Southern distinct population segment Pacific eulachon (*Thaleichthys pacificus*)
15. Southern distinct population segment green sturgeon (*Acipenser medirostris*)
16. Sunflower sea star (*Pycnopodia helianthoides*)

NMFS also concluded that the proposed action is not likely to adversely affect Southern Resident killer whale (*Orcinus orca)* and their designated critical habitat.

As required by section 7 of the ESA, we are providing an incidental take statement (ITS) with the opinion. The ITS describes reasonable and prudent measures NMFS considers necessary or appropriate to minimize the impact of incidental take associated with the proposed action. The ITS also sets forth terms and conditions, including reporting requirements, that the Federal action agencies must comply with to carry out the reasonable and prudent measures. Incidental take from actions that meet these terms and conditions will be exempt from the ESA's prohibition against take of the listed species considered in this opinion.

This document also includes the results of our analysis of the proposed action's effects on essential fish habitat (EFH) pursuant to section 305(b) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA), and includes conservation recommendations to avoid, minimize, or otherwise offset potential adverse effects on EFH. Section 305(b)(4)(B) of the MSA requires Federal agencies to provide a detailed written response to NMFS within 30 day after receiving these recommendations.

If the response is inconsistent with the EFH conservation recommendations, the EPA must explain why it will not follow the recommendations, including the scientific justification for any disagreements over the effects of the action and the recommendations. In response to increased oversight of overall EFH program effectiveness by the Office of Management and Budget, NMFS established a quarterly reporting requirement to determine how many conservation recommendations NMFS provide as part of each EFH consultation and how many are adopted by the action agency. Therefore, we request that in your statutory reply to the EFH portion of this consultation, you clearly identify the number of conservation recommendations accepted.

Please contact NMFS West Coast Region Willamette Branch at 503-230-5400 if you have any questions concerning this consultation, or if you require additional information.

Sincerely,

Kathleen Wells
Assistant Regional Administrator
Oregon Washington Coastal Office

cc: Hunter Young, EPA Region 10 - Oregon Operations Office

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

Portland Harbor Superfund Site Cleanup Activities

NMFS Consultation Number: WCRO-2021-01886

Action Agency: Environmental Protection Agency Region 10

Affected Species and NMFS' Determinations:

ESA-Listed Species	ESA Status	Is the action likely to adversely affect this species or its critical habitat?	Is the action likely to jeopardize this species?	Is the action likely to destroy or adversely modify critical habitat for this species?
Lower Columbia River Chinook salmon	T	Yes	No	No
Upper Willamette River Chinook salmon	T	Yes	No	No
Upper Columbia River spring-run Chinook salmon	E	Yes	No	No
Snake River spring/summer run Chinook salmon	T	Yes	No	No
Snake River fall-run Chinook salmon	T	Yes	No	No
Columbia River chum salmon	T	Yes	No	No
Lower Columbia River coho salmon	T	Yes	No	No
Snake River sockeye salmon	E	Yes	No	No
Lower Columbia River steelhead	T	Yes	No	No
Upper Willamette River steelhead	T	Yes	No	No
Middle Columbia River steelhead	T	Yes	No	No
Upper Columbia River steelhead	T	Yes	No	No
Snake River Basin steelhead	T	Yes	No	No
Southern green sturgeon	T	Yes	No	No
Eulachon	T	Yes	No	No
Sunflower sea star	P	Yes	No	No
Southern Resident Killer Whale	E	No	No	No

Affected Essential Fish Habitat and NMFS Determinations:

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:

Kathleen Wells
Assistant Regional Administrator
Oregon Washington Coastal Office

Date: May 16th, 2025

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1. INTRODUCTION

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

1.1. Background

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

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

Updates to the regulations governing interagency consultation (50 CFR part 402) were effective on May 6, 2024 (89 Fed. Reg. 24268). We are applying the updated regulations to this consultation. The 2024 regulatory changes, like those from 2019, were intended to improve and clarify the consultation process, and, with one exception from 2024 (offsetting reasonable and prudent measures), were not intended to result in changes to the Services' existing practice in implementing section 7(a)(2) of the Act. 89 Fed. Reg. at 24268; 84 Fed. Reg. at 45015. We have considered the prior rules and affirm that the substantive analysis and conclusions articulated in this biological opinion and incidental take statement would not have been any different under the 2019 regulations or pre-2019 regulations.

We completed a 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 at the NOAA Library Institutional Repository [https://repository.library.noaa.gov/welcome]. A complete record of this consultation is on file at the Oregon Washington Coast Office, Portland, Oregon.

Over the past two decades, private, state, and federal entities have investigated environmental conditions at the Portland Harbor Superfund Site (Site). In 2001, a group of potentially responsible parties called the Lower Willamette Group (LWG) entered into an administrative order on consent, Docket No. CERCLA-10-2001-0240, to perform the remedial investigation (RI) and feasibility study (FS) (EPA 2001, 2003a, 2006). The RI report (EPA 2016a), prepared by LWG and modified by EPA, describes the nature and extent of contamination at the Site. As part of the RI, a baseline ecological risk assessment (BERA) and a baseline human health risk assessment (BHHRA) were completed (Windward Environmental LLC [Windward] 2013 and Kennedy/Jenks Consultants [Kennedy/Jenks] 2013, respectively).

The EPA established Remedial Action Objectives (RAOs) for the Site, which are presented in the record of decision (ROD). RAOs consist of media-specific goals for protecting human health and the environment. RAOs provide a general description of what the cleanup is expected to accomplish and help to focus alternative development and evaluation. The RAOs cover human health and ecological (and combined human health and ecological objectives). For human health, RAOs consider sediment, biota, surface water, and groundwater. For ecological factors, RAOs consider the benthic food web in sediments and water quality. Finally, for human health and ecological factors combined, the RAO considers streambank condition and quality.

1.2. Consultation History

As the lead federal action agency, the EPA is proposing to use its CERCLA and SARA authorities to oversee remedial designs submitted by performing parties for implementing individual remedial action projects intended to address contamination within the Superfund Site. The purpose of the proposed action is to reduce potential risks from contaminated sediments, surface water, groundwater, biota, and adjacent riverbanks within and along the approximately 10-mile reach of the Willamette River, which comprises the site.

The proposed action triggers ESA section 7 consultation because of its potential impacts on 16 ESA-listed species and their designated critical habitats, including Lower Columbia River (LCR) Chinook salmon (*Oncorhynchus tshawytscha*), Upper Willamette River (UWR) Chinook salmon, Upper Columbia River (UCR) spring-run Chinook salmon, Snake River (SR) spring/summer-run Chinook salmon, SR fall-run Chinook salmon, Columbia River (CR) chum salmon (*O. keta*), LCR coho salmon (*O. kisutch*), SR sockeye salmon (*O. nerka*), LCR steelhead (*O. mykiss*), UWR steelhead, Middle Columbia River (MCR) steelhead, UCR steelhead, Snake River Basin (SRB) steelhead, Southern distinct population segment Pacific eulachon (*Thaleichthys pacificus*), Southern distinct population segment green sturgeon (*Acipenser medirostris*), and Southern Resident killer whale (*Orcinus orca*). The proposed action also triggers Essential Fish Habitat consultation based on its potential impacts on EFH as designated in the Pacific Salmon Fishery Management Plan.

The EPA, with comment from NMFS, initially drafted a biological assessment (BA) in 2016; the document was abandoned without further development due to changing agency priorities. In 2020, EPA resurrected the 2016 BA as a starting point for this programmatic consultation process. Prior to initiating consultation, staff from EPA, U.S. Fish and Wildlife Service (USFWS), and NMFS met twice monthly, starting in June 2020. These planning meetings were a collaborative effort, providing EPA with technical assistance in formulating the proposed action, determining baseline conditions relative to ESA fish use and critical habitat, and framing a suite of conservation measures to be included as part of the proposed action. NMFS reviewed several versions of the draft BA through the summer of 2021. The final BA and request for programmatic consultation was submitted to NMFS in July 2021. NMFS determined the BA was complete, and ESA section 7 consultation was initiated on August 4, 2021.

Updates to the regulations governing interagency consultation (50 CFR part 402) were effective on May 6, 2024 (89 Fed. Reg. 24268). We are applying the updated regulations to this consultation. The 2024 regulatory changes, like those from 2019, were intended to improve and clarify the consultation process, and, with one exception from 2024 (offsetting reasonable and prudent measures), were not intended to result in changes to the Services' existing practice in implementing section 7(a)(2) of the Act. 89 Fed. Reg. at 24268; 84 Fed. Reg. at 45015. We have considered the prior rules and affirm that the substantive analysis and conclusions articulated in this biological opinion and incidental take statement would not have been any different under the 2019 regulations or pre-2019 regulations.

1.3. Proposed Federal Action

Under the ESA, "action" means all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by federal agencies (50 CFR 402.02). Under MSA, Federal action means any action authorized, funded, or undertaken, or proposed to be authorized, funded, or undertaken by a federal agency (50 CFR 600.910). We considered, under the ESA, whether the proposed action would cause any other activities and determined that it would not.

The EPA proposes to permit planned clean-up work within the Portland Harbor Superfund Site (Site) under its authority from CERCLA. The Site is the portion of the Lower Willamette River between approximately river miles 1.9 and 11.8, split into 17 different remedial design areas used to support the assignment of remedial technologies and the evaluation of remedial action alternatives. The EPA proposes to address applicable or relevant and appropriate requirements (ARARs) using a programmatic approach, described in detail after the consultation history. Responsible parties would carry out the cleanup actions under the requirements and prescription of the program, with monitoring and other oversight carried out by contractors and EPA.

The underlying actions and requirements of the program include (1) a suite of cleanup activities; and (2) a suite of project design criteria (PDCs). The proposed activities and project design criteria address contamination through multiple individual project designs to be applied at discrete sediment management areas (SMAs). Finally, up to three transload facilities may be constructed, operated and ultimately decommissioned within or near the Site. The proposed action will reduce potential contamination risks to acceptable levels consistent with the remedial action objectives (RAOs) established for the Site in the record of decision (ROD) signed on January 3, 2017 (EPA 2017a). The EPA will likely approve the implementation of no more than three remedial action projects to occur simultaneously.

The EPA entered into a 2001 memorandum of understanding (MOU) with the Oregon Department of Environmental Quality (DEQ), six federally recognized tribes, two other federal agencies, and one other state agency (DEQ 2001). The DEQ is working with the City of Portland under an intergovernmental agreement to identify and control upland sources impacting the Site through 39 city outfalls (City of Portland 2012), and with the Oregon Department of Transportation to control sources in highway and bridge runoff drained to the Site through 32 outfalls (DEQ 2016). Contaminated riverbanks will be remediated where they are contiguous with or adjacent to in-river contamination or where they pose a risk of recontamination to areas remediated under the selected remedy. The DEQ may also undertake some response action for riverbanks that are the subject of the ROD, as necessary to expedite source control of contaminated upland areas. The proposed action includes those DEQ activities that will require approval or other federal action on the part of EPA for them to be implemented. To the extent these activities do not have a Federal nexus, they are part of the environmental baseline (or, if future, then cumulative effects).

In implementing the proposed action, i.e., permitting clean-up work under CERCLA, the applicant anticipates that certain remedial technologies are most likely to be employed by responsible parties and so these technologies are incorporated into the proposed action and are fully described in the Section 1.3.1. Remedial technologies not listed below are not considered part of the proposed action and so are not covered by this opinion (including the Incidental Take Statement). In summary, cleanup work is anticipated to require dredging, capping (including shoreline/revetment repair to contain contaminated material), in-situ treatment, ex-situ treatment, dewatering, wastewater treatment, disposal, transportation, and piling removal and installation. Additionally, the EPA intends to oversee the construction and operation of up to three transload facilities as part of the proposed action, which will facilitate the loading and transport of contaminated material in a controlled setting for transport offsite.

1.3.1 Remedial Activities Included in the Proposed Action

Dredging and Excavation

Removal of soil/sediments can be accomplished using dredging or excavation equipment either while submerged or after water has been diverted or drained. Any method of sediment removal typically requires dewatering followed by transport to a disposal facility (e.g., certified landfill). For nonaqueous phase liquids (NAPL) or highly toxic principal threat waste (PTW), treatment through solidification/stabilization or thermal desorption would typically be required prior to disposal. The program requires contractors to treat water from dredged/excavated sediment before returning that water to an appropriate receiving water body. The action area is subject to dredging for navigation to maintain waterways for recreational, national defense, and commercial on-water uses. Dredging will affect approximately 238 acres. As outlined in EPA's Revised Draft Remedial Action Sequencing Memo, the expected total amount of material dredged will not exceed 366,000 cubic yards per season, based on 3,000 cubic yard per day production rate, and up to three remedial action areas may be dewatered, dredged, or capped simultaneously.

Mechanical dredging entails mechanically digging or gathering sediment from the bottom surface of a body of water, typically through the use of a bucket. Hydraulic dredges add water to the sediment and transport it as slurry through a pipeline to another location. The most appropriate and effective method to remove sediment and riverbank soils will be determined during remedial design on a project-specific basis. Environmental/closed buckets and fixed-arm dredges are preferred for dredging to reduce sediment releases to the water column. Articulated fixed-arm dredges would be the preferred dredging option owing to the greater bucket control that can be achieved versus cable-operated dredges. However, cable-operated dredges may be required in certain conditions, such as where water depths exceed 40 feet. In addition, traditional clamshell buckets may be required in certain conditions, such as areas with significant riprap, compacted bottom material, or debris.

Following dredging, residual management layers, assumed to be 12 inches in thickness, would be placed over the leave surface as soon as practicable within the removal area and surrounding area to cover the exposed surface and isolate any dredge residuals and remaining contaminated sediments. In the navigation channel, FMD areas, and intermediate regions, residual layers will consist of sand (amended as necessary) to prevent exposure to residuals above CULs (cleanup level). In the shallow region, residual management will consist of capping or backfilling to grade to prevent exposure above CULs and to minimize adverse effects on in-river and riparian habitat, including the loss of shallow-water habitat.

For the cost analysis in the feasibility study, it was assumed that land-based excavators would be used for removal of contaminated riverbank materials or near-shore sediments in locations above the water level present at the time of the work to limit the transport of disturbed riverbank materials in the river. The actual approach used (land- or water-based excavation) for riverbank excavation will be location-dependent and will be refined during remedial design. Removal of riverbank material would most likely occur in the late summer and early fall when the river stage is low.

Capping

Containment entails the physical isolation (sequestration) or immobilization of contaminated sediments, thereby limiting potential exposure to and mobility of contamination. Sediment caps are designed to reduce potentially unacceptable risks through (1) physical isolation of the contaminated sediment or soil to reduce exposure because of direct contact and reduce the ability of burrowing organisms to move contaminants to the surface, (2) stabilization and erosion protection to reduce resuspension or erosion and transport, and/or (3) chemical isolation of contaminated media to reduce exposure from contaminants transported into the water column. Capping technologies require monitoring and maintenance in perpetuity to ensure containment measures are performing successfully because contaminated sediment is left in place. Typical cap maintenance may include the placement of additional materials, including armoring or treatment material (organoclay), and the replacement of warning buoys. Monitoring would entail periodic visual inspections of near-shore areas, regular bathymetric surveys (and possibly diver surveys if issues are identified), and sampling, including porewater sampling. In addition, Institutional Controls (ICs) will be required to maintain the function and integrity of caps. Capping also includes riverbank construction activities, including excavation and capping, covering, and/or armoring of certain contaminated riverbanks within the action area. Debris and certain structures present on contaminated riverbanks may also be removed during construction.

The proposed program will use engineered sand caps sufficient to protect against erosive forces resulting from wind and vessel-generated waves, current, or propeller wash while minimizing adverse effects on the in-river and riparian habitat, including the loss of shallow-water habitat. Any proposed capping in the navigation channel and future maintenance dredge areas will consider the current and authorized channel depth, the potential for an increase to the currently authorized channel depth, future navigation and maintenance dredging, and an appropriate buffer depth to ensure the integrity of the cap. In addition, no area shall be capped while (i.e., at the same time) an area directly adjacent, whether upstream or downstream, is completing dredging.

Some caps will be designed to incorporate in-situ treatment through the placement of a reactive layer of activated carbon in powdered or granular form and/or other reactive material, which modifies the sorption capacity for nonpolar organics and certain metals such as mercury. Placement may be through broadcast placement of sand mixed with activated carbon or use of a commercially proprietary product. The concentration of the placed activated carbon will be determined during remedial design, but it must limit bioavailability sufficiently to meet the

RAOs and CULs for the Site and minimize the potential for adverse impacts to the benthic community and other aquatic organisms.

Site-specific treatability studies may be required during remedial design to determine the effectiveness of the treatment technology in the Site's environment and develop specific design characteristics, such as the activated carbon application rate.

Cap design will also consider the following design elements:

- Principal Threat Waste (PTW) (NAPL/Not Reliably Contained) – Significantly Augmented Cap: Where a cap is constructed in an area of PTW in the form of NAPL or not reliably contained COCs, cap design will include organoclay, other reactive material, and/or low permeability material, as necessary, to provide a sufficient chemical isolation layer to reliably contain underlying contamination (i.e., to porewater cleanup values).
- PTW (Highly Toxic) – Reactive Cap: Where a cap is constructed in an area of highly toxic PTW, cap design may require the use of activated carbon and/or other reactive material, as necessary, to meet RAOs.
- Areas of Groundwater Contamination and/or Porewater Exceedance – Reactive Cap: Cap design will require the use of activated carbon, other reactive material, and/or low permeability materials, as necessary, to prevent contaminant migration through the cap, accounting for the degree of upland source control.
- Structures: Caps placed below or adjacent to structures will consider the logistics of placing capping material below structures and any physical constraints adjacent to the structure, including sediment bed slope, current and future navigation uses, and propeller wash. Minor structures, such as outfalls, will be moved to accommodate dredging and capping when necessary. Dilapidated structures with low function, permanence, and lifespan will be removed.
- Debris: Cap design will consider the presence or absence of debris (e.g., remnant pilings). Any debris that hinders expected cap performance will be removed prior to cap placement unless it can be demonstrated that it is infeasible to remove the debris.
- Slope: Cap design will consider the slope of the sediment bed. Sediment caps will be designed to remain in place. This may require the removal of material to lessen the slope angle or incorporation of buttresses at the base of the slope to maintain stability and promote establishing habitats.
- Flood Rise and Navigation: Caps will be designed to avoid adverse impacts to the floodway, consistent with the Executive Orders for Floodplain Management (Executive Orders 11988 and 13690) and Federal Emergency Management Agency regulations. Additionally, caps will be designed to avoid adverse impacts to current and future navigation based on expected cap thickness, authorized channel depth, and appropriate buffer. This may limit cap construction in some locations or require removing contaminated sediment prior to cap placement.
- Land and In-River Use: Caps will need to be designed consistent with anticipated uses so that the cap is not destroyed or damaged by those uses and does not unnecessarily hinder those uses. As described in Sections 2.4.9.2 and 2.4.9.3, waterway and land use restrictions will be implemented to maintain the integrity of caps.

Additional requirements may be determined during remedial design and in coordination with NMFS.

In-Situ Treatment

In-situ treatment of sediments refers to chemical, physical, or biological techniques for reducing contaminant concentrations, toxicity, bioavailability, or mobility while leaving the contaminated sediment in place. In-situ treatment options selected in the remedy include amendments to caps, residual layers, and in-situ stabilization and solidification (ISS). In-situ treatment will be used in some areas to address contamination underneath and around pilings, docks, berthing or mooring dolphins, and other structures servicing active wharfs or shore-based facilities that will remain intact. In-situ treatment may also be applied to areas where principal threat waste that cannot be reliably contained or nonaqueous phase liquid is left in place or where residual groundwater plumes may discharge to the river.

Amendments to caps, such as the addition of activated carbon to the sediments, which increases the sorption capacity of non-polar organics and certain metals such as mercury, will be used to sequester contamination. Amendments can be engineered to facilitate placement in aquatic environments by using an aggregate core (such as gravel) that acts as a weighting component and resists re-suspension, so that the mixture is reliably delivered to the sediment bed, where it breaks down slowly and mixes into sediment by bioturbation.

Using ISS is a method for remediating contaminated sediments through a physical modification and chemical reaction to bind the target compounds (i.e., solidification) and/or transform them into a less mobile form (i.e., stabilization). Through the physical process of solidification, the contaminated material is encapsulated and thus stabilized. A grout mixture is typically injected into the sediment, and mixing occurs within columns constructed by drilling into the sediment using a rotating auger that is advanced in a single location from the mudline. After injection occurs, the auger mixes the grout and sediment until the mixture meets homogenization and field sampling objectives. While the mixing occurs, the auger remains in the column and moves up and down through the column as needed to complete the mixing. The cement mixture is likely to swell while curing, and the well will need to be dredged, consistent with dredge BMPs and PDCs, to an elevation that maintains shallow-water habitat.

Ex-Situ Treatment

Ex-situ treatment involves the application of chemical, physical, or biological technologies to transform, destroy, or immobilize contaminants following removal of contaminated soil/sediments. Depending on the contaminants, their concentrations, and the composition of the soil/sediment, treatment of the soil/sediment to reduce the toxicity, mobility, or volume of the contaminants before disposal may be warranted. Available disposal options and capacities may also affect the decision to treat some sediment. Regulatory requirements, such as RCRA land disposal restrictions, may influence the need for treatment and a determination that some portion of the material constitutes PTW and, as such, treatment would be considered. Prior to disposal, an evaluation of removed soil/sediments containing any RCRA listed or characteristic hazardous wastes, pesticide residue, or manufactured gas plant waste subject to the 2004 dispute decision (Opalski 2004) will be conducted to determine the need for and extent of treatment appropriate for the off-site disposal requirements. Ex-situ treatment technologies discussed in the EPA's Record of Decision (ROD) for the *Portland Harbor Superfund Site Portland, Oregon* (EPA

2017) include thermal treatment and solidification/stabilization using quicklime, although other treatment options were retained and may be considered during remedial design. The proposed action requires dewatering of dredged sediments before use in ex-situ treatment.

Dewatering

The proposed action requires the use of dewatering technologies to reduce the amount of water in dredged sediment and prepare the sediment for transport and treatment or disposal. As described below, all wastewater generated by dewatering will either require treatment to meet water quality standards prior to discharge to the Lower Willamette River or disposal at a publicly owned treatment works (POTW). In many cases, the dewatering effluent will need to be treated before it can be disposed of properly or discharged back to receiving water. Dewatering also would facilitate ex-situ treatment. Several factors would be considered when selecting an appropriate dewatering treatment technology, including physical characteristics of the sediment, selected dredging method, and the required moisture content of the material to allow for the next handling, treatment, transport, or disposal steps in the process. The specific dewatering technologies will be determined during remedial design based on the characteristics of the removed sediment, short-term impact considerations, and transport/treatment/disposal requirements.

Three categories of dewatering that are regularly implemented include passive dewatering, mechanical dewatering, and reagent-enhanced dewatering/stabilizing methods. These methods are often used in combination to address project-specific dewatering requirements. The actual method used will be location-dependent and will be refined during remedial design.

Passive dewatering (also referred to as gravity dewatering) is facilitated through natural evaporation, consolidation, and drainage of entrained water to reduce the dredged sediment water content. It is most often conducted at an onshore temporary holding facility, such as a dewatering lagoon or temporary settling basin. In-barge settling and subsequent decanting can also be an effective passive dewatering method and can reduce the overall time needed for onshore passive dewatering operations. Water generated during the dewatering process is typically discharged to receiving waters directly after treatment or may be captured and transported to an off-site treatment and discharge location. Normal passive dewatering typically requires little or no treatability testing, although characteristics of the sediment, such as grain size, plasticity, settling characteristics and NAPL content, are typically considered to determine specific dewatering methods, size the dewatering area, and estimate the time frame required for implementation.

Passive dewatering is generally effective and capable of handling variable process flow rates but can require significant amounts of space (depending on the volume of material processed and the settling characteristics of the sediment) and time for significant water content reduction. Passive dewatering is a widely implemented dewatering technology for mechanically dredged sediments. It is also amenable to hydraulic dredging with placement into a settling basin or with the use of very large geotextile tubes to confine slurry and sediment during passive dewatering. Hydraulic dredge sediment dewatering with geotextile tubes has been implemented at several sediment remediation sites. However, it typically requires project-specific bench-scale evaluations during remedial design to confirm its compatibility with site sediments and properly select and size the geotextile tubes. Under this method, geotextile tubes would be placed in upland locations.

Mechanical dewatering involves the use of equipment, such as centrifuges, hydrocyclones, belt presses, or plate-and-frame filter presses, to separate coarse materials or squeeze, press, or otherwise draw water out from sediments. Mechanical dewatering is typically used in combination with hydraulic dredging to reduce the water content of the dredged slurry prior to ex-situ treatment (e.g., thermal) and/or disposal of the dewatered sediment.

The mechanical dewatering treatment train typically includes screening to remove materials such as debris, rocks, and coarse gravel. If appropriate, polymers may be added for thickening prior to dewatering. These steps result in a dewatered cake that achieves project-specific volume and weight reduction goals for the dredged sediment. The mechanical dewatering process can be scaled to handle large volumes of sediment but requires operator attention, consistent flow rates, and consistent sediment feed quality.

Reagent dewatering is an ex-situ treatment method in the category of stabilization/solidification methods. This technology removes water by adding a reagent to the bulk sediment that binds with the water within the sediment matrix to enhance geotechnical properties and may coincidentally immobilize leachable contaminants (typically metals). This process increases the mass of the sediment because of the addition of the reagent mass. For situations where dewatering is the single goal, the most cost-effective, available, and effective reagent or absorptive additive is used, which, depending on site conditions and economics, could include quicklime, Portland cement, fly ash, diatomaceous earth, or sawdust, among others. Reagent mixtures can be optimized to provide enhanced strength or leachate retardation to meet specific project requirements.

Dewatering by the addition of reagents is effective and has similar or smaller space and operational requirements as compared to mechanical dewatering. In some cases, reagent addition and mixing can be conducted as part of the dredged material transport and handling processes, either on the barge or as dredged material is loaded into trucks or railcars. In other cases, it can be added and mixed after off-loading to an upland staging area. Also, reagent addition may be used in combination with other forms of dewatering (e.g., filter press) and ex-situ treatment

Wastewater Treatment

Dewatering dredged material requires managing the wastewater generated during the dewatering process (dredged material typically has a water content ranging from 50 to 98 percent, depending on the dredging method) along with contact water (e.g., precipitation that has been in contact with contaminated material) and/or water from other facility operations (e.g., decontamination water). The purpose of wastewater treatment is to prevent adverse impacts on the receiving water body from the discharge of dewatering water to the Lower Willamette River.

Wastewater will be generated by dewatering steps, and this water will either require treatment to meet water quality standards prior to discharge to the Lower Willamette River or disposal at a publicly owned treatment works (POTW). While the feasibility study assumes a representative set of process options for the general screening and alternative development procedures, this does not imply that other process options are screened out from future consideration during remedial design. Unless specifically noted otherwise, all process options discussed in this section would be potential options during remedial design. For example, there may be opportunities for handling and discharging water, including the addition of amendments to bind or absorb water, use of upland transfer or disposal holding areas to allow water to clarify before discharge, and discharge to existing POTWs.

A wastewater treatment plant may be included in the on-site management of dredged material. An on-site wastewater treatment plant to manage wastewater for a facility handling sediment from the Site may include coagulation, clarification, multistage filtration, and granular activated carbon adsorption with provision for metals removal, if necessary. The primary difference in the wastewater treatment plant for a hydraulic dredging operation, as compared to a mechanical dredging operation, would be the volume of wastewater to be treated. As hydraulic dredging results in a larger volume of sediment-water slurry to be managed, a hydraulic dredging wastewater treatment plant would require a larger footprint.

Dredge Spoil Disposal

Disposal refers to the placement of dredged or excavated material and process wastes into a temporary or permanent structure, site, or facility. The goal of disposal is generally to manage residual wastes to prevent contaminants associated with them from impacting human health and the environment.

Removed media will be disposed of at a certified upland landfill disposal facility. For costing purposes in the FS, landfill disposal options considered disposal in a Resource Conservation and Recovery Act (RCRA) Subtitle D landfill and RCRA Subtitle C or Toxic Substances Control Act landfill. The majority of the dredged and excavated material is expected to be eligible for Subtitle D landfills; however, some material will likely need special handling (e.g., for asbestos or other materials). Dredged sediments meeting certain criteria will be disposed of at upland landfill disposal facilities. Prior to transport, sediments would be dewatered and the wastewater would be treated.

Dredge Spoil Transportation

Transportation will be a necessary component of removal of contaminated sediments from the Site. The transportation method would be based upon the compatibility of that transportation method to the other process options. The most likely transportation methods are truck, rail, barge, or a combination of these. These transportation methods are briefly discussed below.

Truck transportation includes the transport of dewatered dredged material over public roadways using dump trucks, roll-off boxes, or trailers. Rail transportation includes the transport of dewatered dredged material via railroad tracks using gondolas or containers. Rail transport is desirable where sediment is shipped over long distances, for example, to out-of-state treatment or disposal facilities. Rail transport may require the construction of a rail spur from a sediment handling facility to a main rail line. Barge transportation includes the transport of dredged solids directly to a processing (dewatering) facility or the transport of dewatered dredged material to a transload or disposal facility. Barge transport likely would be used for short distances, such as from the dredging location to the transload facility. In addition, barge transport may be considered for longer distances if dredged material is hauled to treatment or disposal locations that can accept barge-loaded dredged material. Sediment would be dredged from within the Site, loaded onto barges, taken to a transload facility where it would be prepared for upland transportation and transferred to rail or truck, and then transported to the landfill for disposal.

According to the ROD, approximately 1,985 barge loads and 198,615 truckloads or 49,606 rail loads are assumed to transport the removed material. If an onsite transloading facility were constructed, approximately the same number of truckloads and/or rail loads are assumed for offsite disposal. Additionally, 941 barge loads, 116,829 truckloads, or 24,258 rail loads are assumed to transport material into the Site.

Construction and Operation of Dredge Spoil Transloading Facility

The transloading of sediments and debris is anticipated to be conducted at up to 3 transload facilities constructed along the Lower Willamette River within or near the Site and near existing rail transport. It is anticipated that any transload facility would be constructed on land with existing industrial use so that uplands supporting natural habitat would not be impacted. Potential locations for any transload facility will be evaluated during future phases of remedial design. A conceptual transload facility design has been developed for inclusion in the proposed action and so the potential effects of its construction and operation – as well as its decommissioning -- are analyzed in this opinion.

The conceptual design of a transload facility consists of a waterfront pier with moorage for at least two barges containing contaminated materials, and a transfer apparatus consisting of a crane-mounted clamshell bucket and hopper/conveyor assembly. The ROD estimated the transload facility would require 20 acres of uplands adjacent to the pier, with 15 acres to include a bermed stockpile area and five acres for support activities. All transload facilities would be fully contained to prevent sediment and associated dredge liquids from entering the river.

To anticipate demands on a transload facility, the EPA made assumptions about the dredged and excavated material to be handled there. The proposed action is anticipated to require disposal of approximately 3,000,000 yd^3 of dredged sediment and approximately 123,000 yd^3 of excavated soil from riverbanks. The ROD assumed a total materials volume of 3,666,427 yd^3 to be barged to transload facilities, which includes amendments added for in-barge stabilization and mixing.

The ROD assumed the following regarding contaminated materials handling:

- Maximum 5,000 tons (3,333 yd^3) per day loaded out (using a conversion factor of 1.5 tons per yd^3)
- 2 to 3 barges per day
- Transload volume per year = 230,000 yd^3 based on 85 to 105 days of dredging (5 to 6 days/week) within the 120-day in-water construction window
- 700 yd^3 dredged per day at each remedial area
- 2 to 3 remedial areas being dredged at one time

The pier for a transload facility needs to support the weight of both the saturated contaminated sediments and heavy equipment needed to move the sediments from the barge and convey them to a container for transport. It must accommodate a barge with a draft of at least 15 feet. The top surface would need to extend into the water to match the elevation of the shoreline while accommodating the barge draft.

The EPA assumes any single transload facility would be composed of an approximately 22,000-square-foot deck with a 210-foot-long by 90-foot-wide pier, and proposes up to three transload facilities may be constructed of equivalent size as part of the project. The pier is assumed to be designed to accommodate distributed loads ranging from 500 to 600 pounds per square foot and constructed on a steel-concrete piling system. The dredged material would be off-loaded from the barge using clamshell buckets and managed in various ways, including placement onto a conveyor, in a bermed stockpile area, or directly into containers assumed to be 34-ton capacity and 20- by 40-feet. Wood and other debris in the dredged material would be removed and stockpiled for transport to a permitted landfill. If one transload facility cannot accommodate the extent of dredged material expected annually, up to three total transload facilities may be built.

To support each pier, approximately 100 steel-concrete pilings (20 feet on center) are assumed and recommended over the more than 450 wood pilings (approximately 6 feet on center) that would be required if wood pilings were used. The EPA also assumes each pier will include two mooring dolphins, one at each end of the pier, 50 to 75 feet beyond the ends of the pier, used for mooring line tie-up during the off-loading operations. These dolphins are to be connected to each pier by walkways. It is assumed that these dolphins would be constructed from wood pilings.

A stormwater management plan would be required to manage stormwater and dredge liquids at each transload facility within or near the Site. New impervious surface created as part of the proposed action will comply with NMFS stormwater treatment and detention requirements outlined in SLOPES Transportation and Stormwater (SLOPES STU) (NMFS 2014a), or replacement biological opinion, and require NMFS individual approval of a stormwater management plan. A transload facility would be designed and constructed to contain all rainwater and water draining from stockpiled sediment so that impacts to nearby waterbodies and offsite wheel tracking of contaminants are minimized. Each 15-acre facility would be graded and paved with asphalt. Low-profile perimeter asphalt curbs may be placed depending on existing site features. The grading would be sloped so the water would flow toward interior locations, catch basins, and collection sumps. Sumps would be equipped with sump pumps/level indicators to pump collected water to an on-site treatment system. A typical treatment system would include sand filters as a first stage to remove particles and granular activated carbon tanks to remove dissolved compounds.

Stormwater treated with this system is anticipated to be discharged through a National Pollutant Discharge Elimination System (NPDES) outfall to the river. In either event, the water would be monitored for water quality. Typical water quality parameters may include turbidity, pH, and DO. Periodic (monthly) sampling may include specific parameters such as total organic carbon, PCBs, PAHs/semi volatile organic compounds, and metals. The stormwater pollution prevention plan (SWPPP) would outline the appropriate COCs to be monitored and the required frequency of monitoring of the stormwater discharge based on /project area-specific contaminants.

The ROD assumed the 15-acre stockpile area of a transload facility would receive 37 inches per year of rain. The amount of water that would collect on the paved areas, assuming 15 acres and 37 inches of rain, would be about 15 million gallons annually. A facility may be in operation for only about six months of the year and primarily during the dry season since the in-water work window is from July to October, a period that averages a total of less than 6 inches of rain annually. Therefore, not all of this stormwater would be generated during operating months.

Depending on dredged sediment handling (dewatering on barges, or not) and the amount of water within the sediment, there will be variable quantities of water that drain from the sediment while it is stockpiled at a transload facility. Based on the projected annual quantity of dredged sediment (230,000 yd^3), it was estimated that a total of 7.5 million gallons of water would drain from the stockpiled sediment (LWG 2012). Factors that affect this projected volume include sun exposure, wind, the possible use of drying agents, dredging techniques, sediment physical properties, and the length of storage. Regardless of the volume produced, water treatment systems would be modularized and installed to store and treat the water entrained in the dredged sediment.

Pilings and In-water Structures

The proposed action would include removing some pilings and structures during dredging and capping. Temporary structures may also be installed for work area isolation, sediment containment, or fish exclusion during construction. Obsolete pilings and dilapidated structures with low function, permanence, and lifespan will be removed in accordance with the ROD Figure 28 Technology Application Decision Tree. The EPA expects major and minor structures with medium to high function, permanence, and lifespan to remain in place. Any existing structure that is replaced must remain within the existing footprint. The EPA expects temporary docks to be relocated to allow access to contaminated material, and marine salvage equipment will likely be used to remove structures. Pilings may either be removed or cut off at the base using divers, though removal is preferred where pilings could create preferential pathways through engineered caps. Landowners may also prefer piling removal. For treated piles, the EPA recognizes NMFS' preference for vibrating out pilings rather than cutting; therefore, in most instances, contractors will be directed to first attempt to vibrate out the treated piling, and if it should break during that process, the contractor would cut the piling below mudline. At many locations, creosote-treated piling may be replaced with a different piling type, which would remove a source of PAHs to the sediment. Any pile installation will intermittently at a rate of 5 to 10 pile per day spread across 1 to 40 days of a typical in-water work window, or for a shorter period split between two work seasons per project.

Enhanced Natural Recovery

The ENR concept involves enhancing or accelerating natural recovery processes to reduce risks within an acceptable time frame. As with MNR, ENR entails monitoring to assess whether natural processes continue to occur and at what rate they may be reducing contaminant concentrations in surface sediment. Areas that are stable (exhibit low shear stress) and are recovering naturally are candidates for ENR. ENR would be applicable to certain areas of the Site with lower levels of contamination and net sedimentation, and where significant erosion is not a concern.

The applicant will use ENR by placing a thin-layer cover, assumed to be 12 inches of sand or other appropriate benthic substrate, to facilitate meeting the RAOs and CULs established for the Site over time. A 12-inch layer of clean material (e.g., sand) would accelerate natural recovery through several processes, including dilution of contaminant concentrations in sediment and decreasing exposure of organisms to the contaminated sediment. A thin-layer cover is typically different than an isolation cap because it is not designed to provide long-term chemical and physical isolation of contaminants and does not require that the layer be maintained.

The grain size and organic carbon content of the clean sediment to be used for a thin-layer cover would be selected to approximate common substrates found in the area and provide suitable habitat for benthic organisms native to the Lower Willamette River. Timing of the placement of ENR materials may be adjusted or sequenced to avoid undue acute impacts to the benthic environment. Clean sediment would be placed in a uniform thin layer over the contaminated area or placed in berms or windrows, allowing natural sediment transport processes to distribute the clean sediment to the desired areas.

Monitored Natural Recovery (MNR)

Natural recovery typically relies on ongoing, naturally occurring processes to contain, destroy, or reduce the bioavailability or toxicity of contaminants in sediments. These processes may include physical (burial and sedimentation or dispersion and mixing), biological (biodegradation), and chemical (sorption and oxidation) mechanisms that act together to reduce the risk posed by contaminants.

However, not all-natural processes result in risk reduction; some may increase or shift risk to other locations or receptors. MNR does not include active remedial measures but does include monitoring of the water column, sediments, and biota tissues to assess whether natural processes continue to occur and at what rate they may be reducing contaminant concentrations in surface sediments. Where empirical data indicates that MNR may be sufficient to meet RAOs in a reasonable time frame compared to remedies such as dredging and capping (EPA 2005), MNR will be considered in lieu of an ENR technology assignment, such as in Swan Island Lagoon. Details regarding sampling media and timing of sampling and analysis to determine the effectiveness of MNR is described in Section 2.4.8. However, should long-term monitoring determine that natural recovery is not occurring as expected, additional sediment cleanup and source control actions may be required to reach RAOs. This would be determined through the CERCLA 5-year review process.

Monitoring

The applicant will monitor short- and long-term effectiveness and whether the proposed action is meeting the remedial goals. This includes collecting data to inform remedy design and monitoring sites at planned intervals after remedy activities are completed, as well as gathering information to address data gaps that were not anticipated. Pre- and post-action sampling would all be done in accordance with standard operating procedures (SOPs), sampling plans, and quality assurance plans developed by the responsible parties and approved by the EPA and with avoidance and minimization measures for monitoring activities.

The EPA proposes the following annual take limits in connection with monitoring activities:

1. Collection of water, porewater, sediment, invertebrate or vegetation samples. Mortality of up to two individuals per year of any fish species considered.

2. Collection of fish or invertebrate tissue samples if non-ESA-listed species. Mortality of up to one percent of non-target fish handled.
3. Collection of fish tissue samples from ESA-listed species for contaminant analysis. Handling of up to five adults of any species, and mortality of up to two hatchery-origin adults from any species. Mortality of up to 250 hatchery-origin and 250 natural-origin juveniles per species, and handling of an additional 250 hatchery-origin and 250 natural-origin juveniles per species.
4. Studies of ESA-listed fish presence/habitat use. Mortality of up to 1 percent of fish handled.

Environmental sampling and monitoring activities will include, but are not limited to:

- Pre-construction sampling: sampling will be conducted to support remedial design by establishing current baseline conditions (pre-construction), to further delineate contamination in construction areas, and to evaluate construction activities and the performance of the remedy. Sampling may include, in addition to other relevant data, surface and subsurface sediment contaminant concentrations, surface water, sediment pore water and groundwater data, bathymetry, flood-rise modeling, fish/shellfish tissue, and NAPL delineation.
- Short-term monitoring will be conducted during construction and post-construction to ensure remedial action performance standards are met, including water quality monitoring.
- Long-term monitoring of caps, dredge areas, and MNR areas after construction: sampling will be conducted to evaluate long-term effectiveness and ensure the remedies function as designed and are protective of human health and the environment and that CULs are met. Statutory 5-year reviews of the remedy will be conducted until unlimited use/unlimited exposure for the Site is achieved. These activities will include, but are not limited to, the collection of sediment, water, benthic invertebrate, and sturgeon and resident fish tissue sampling.
- To monitor compensatory mitigation projects, the EPA will sample to evaluate long-term effectiveness and ensure the anticipated uplift in habitat function is achieved. Sampling activities may include, but are not limited to, habitat feature and vegetation surveys, visual observation or surveys to detect fish species or describe fish communities, collection of benthic invertebrates, and capture of juvenile fish (resident and salmonid).

Monitoring may include biota tissue sampling and analysis, sediment sampling, and surface water sampling. Likely avoidance and minimization measures for monitoring activities include the following:

- All biota collection activities should be conducted according to a field sampling plan and SOPs, or equivalent, similar to those used to guide sample collection activities for the RI and pre-design investigation/baseline (PDI/BL) sampling.
- Biota sampling will employ strategies to limit bycatch. These strategies include selective gear types and bait appropriate for the target species. If methods are proposed that have an increased risk of bycatch (e.g., electrofishing), biota sampling would be conducted during the in-water work window to the extent possible.

- Fish capture activities should be done carefully and in a way that targets the intended species, to the greatest extent possible. If nontarget species are captured, they should be returned to the river as quickly as possible.
- Boat and backpack electrofishing activities should be conducted by field staff appropriately trained for using electrofishing equipment. Electrofishing should be used only if other means of fish capture are determined to be ineffective or not feasible. Electrofishing should be done in accordance with NMFS guidelines (NMFS 2000).
- Surface sediment sample collection, processing, equipment decontamination, and disposal of waste activities should be conducted according to the field sampling plan and SOPs, or equivalent, similar to those used to guide sample collection activities for the RI and PDI/BL sampling.
- Sediment sample locations should be targeted and confirmed using a differential Global Positioning System (GPS) with appropriate corrections and offsets for horizontal and vertical control.
- Surface water sample collection, processing, and equipment decontamination activities also should be conducted according to the field sampling plan and SOPs, or equivalent, similar to those used to guide sample collection activities for the RI and PDI/BL sampling.
- Care should be taken to avoid disturbing the sediment surface during surface water sample collection.

Clean Water Act 404(b)(1) Compensatory Mitigation Actions

Some elements of the proposed action will require compensatory mitigation to offset otherwise unavoidable adverse effects of the proposed action. Unavoidable adverse effects are those that cannot be avoided or minimized through the use of on-site measures. If there are unavoidable impacts to the function of salmonid critical habitat, implementation of CWA Section 404(b)(1) compensatory mitigation requirements would replace any lost habitat functions. The EPA will also require compensatory mitigation to offset loss of habitat and/or habitat function of ESA-listed species. Review and approval of a compensatory mitigation plan (Appendix D) will be required by EPA with additional verification from NMFS.

Remedial activities in shallow-water areas would be conducted in a manner that minimizes permanent habitat loss to the extent possible by restoring elevation, slope, and substrate. However, in some areas, long-term adverse effects on salmonid PBFs would occur and require compensatory mitigation. These effects are summarized as follows:

- Natural Cover: While very limited in the action area, some areas may support natural cover such as riparian vegetation, submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels, and undercut banks that would be removed or disturbed during remedial activities, and it may not be possible to restore natural cover on-site in all of the areas where it is disturbed.
- Substrate and Forage: Some areas of existing sand or gravel may be permanently lost with the placement of engineered caps that use riprap armor as a surface layer, and where placement of beach mix as a top layer is not possible.

- Shoreline Armoring and Slope: As described above, some armoring would occur in shoreline areas, and it may not be possible to restore ideal slopes.
- Habitat Access and Refugia: In some areas, dredging may be required to a depth such that shallow water would be converted to deep water and/or there would be loss of shallow-water habitat complexity, reducing the amount of shallow-water habitat and refugia available.

Clean Water Act Section 404(b)(1) requires the proposed action be designed to avoid or minimize adverse impacts to aquatic resources and waters of the United States. As indicated above, the EPA will also require compensatory mitigation to offset loss of habitat and/or habitat function of ESA-listed species. Compensatory mitigation will be proportional in scale to impacts to ESA-listed species and of sufficient quantity and quality to offset those impacts. A habitat calculator may be used to quantify existing and proposed habitat conditions within each project area. At the time of signature, NMFS does not have a final habitat calculator for the Portland Harbor to offer, but this does not preclude future development of such a tool.

The compensatory mitigation approach for each project submitted under this programmatic would be developed during remedial design once the remedial action is defined and avoidance, minimization and compensatory mitigation measures are developed for each project. Additional project-specific data collection would be conducted, as needed, to supplement existing data needed to quantify impacts to existing habitat conditions and determine EPA's compensatory mitigation requirements for both CWA and ESA-listed species.

Some projects may require compensatory mitigation outside of their project footprint. These compensatory mitigation projects would be constructed within the action area in the Lower Willamette River and/or the Lower Columbia River. These projects would entail the conversion of existing riparian or upland habitat to shallow-water and off-channel habitat with sand/gravel substrates, shallow slopes, and shoreline complexity. Construction of mitigation projects would result in many of the same short-term adverse consequences to species and designated critical habitat as remedial activities, including increased turbidity and temporary loss of benthic foraging habitat. Mitigation projects would be constructed in appropriate areas as approved by the EPA and verified by NMFS. Implementation of the avoidance and minimization measures and BMPs described in Section 2.5 would be required. An alternative to constructing new compensatory mitigation projects scaled to specific remedial activities is to purchase credits from existing restoration banks, if present.

Compensatory mitigation projects are anticipated to improve substrate and forage habitat with the placement of sand/gravel substrates, create or restore shallow slopes, and enhance complexity in off-channel areas with the placement of large wood or other habitat features. Some mitigation projects would likely entail the creation of off-channel habitat to benefit floodplain connectivity, which is highly impaired in the action area. In addition, projects may result in restoration of natural cover with removal of shoreline riprap, bulkheads, or other armoring conditions.

Compensatory mitigation projects will be monitored for at least ten years following construction under a monitoring plan to be submitted by the performing party to the EPA and NMFS. Compensatory mitigation projects will be protected from future development by placement of a deed restriction or conservation easement to protect the conservation value of the project.

1.3.2 Description of the Project Design Criteria

The EPA intends to apply Project Design Criteria (PDCs) to remedial technologies: infrastructure construction, improvement, and operation; and compensatory mitigation activities that may be required, which are all included in the proposed action, including dredging, excavation, capping, covering, residual layer placement, riverbank excavation and capping, piling and structure removal/installation, and any associated in-water work. Measures also apply to associated activities, such as new discharges of wastewater and stormwater from each transload facility. To fall within the proposed action and thus be covered under this Opinion, each project must meet all the applicable criteria outlined in this section.

Some of the design criteria described in this section were developed to serve as “on-site mitigation” to be integrated into the remediation plan to maintain habitat and function that would be altered during implementation of the proposed action. These integrated minimization measures include the use of beach mix as a final substrate layer following dredging and capping in relevant locations; the restoration of water depth and/or provision of additional shallow-water habitat, slope, riparian vegetation where possible; and riverbank slope modification where applicable.

During the remedial design process mitigation elements will be developed and included so to offset or compensate for impacts to ESA-listed species and designated critical habitats by providing equivalent substitute habitats. This will be based on an approach that relates existing habitat to the highest functioning rearing and migration habitat and provides mitigation acreages relative to the creation of this highest functioning habitat. Highest functioning habitat is defined as off-channel, shallow water, or active channel margin (ACM) with a gentle (shallower than 5H:1V) slope; habitat complexity in the form of large wood; and sand and rounded gravel or other habitat-friendly substrate.

1) Program Administration PDCs

Initial rollout

The EPA will cooperate with NMFS to provide an initial rollout of this Opinion for EPA staff to ensure that these conditions are considered at the onset of each project, incorporated into all phases of project design, and that any constraints, such as the need for fish passage or hydrologic engineering review, are resolved early on and not under-designed as add-on features. See example project implementation form for specific review triggers (Appendix A).

Failure to report

If the EPA fails to provide full reports or attend the annual coordination meeting, NMFS will evaluate whether any of the reinitiation triggers in 50 CFR 402.16 have been met and whether incidental take exemptions have been exceeded - and communicate that to EPA.

Review and verification

a. The EPA will review each project to be covered under this Opinion. The EPA will hold pre-construction meetings with all contractors to review proposed project designs and operations, and make changes as necessary to ensure that any responsible party receiving EPA authorization will comply with all of the project design criteria.

b. EPA will submit a pre-construction notification to NMFS for verification that necessary offsets are being met to compensate for unavoidable adverse impacts on ESA-listed species or critical habitat.
c. NMFS must receive notice of any project with any of the following elements:
    i. Dredging, including all requisite dewatering and containment/transport thereof
    ii. Capping
    iii. Piling and treated wood removal, and piling insertion (including sheet piles)
    iv. Construction and operation of a transload facility
    v. Compensatory mitigation. Review and approval of a compensatory mitigation plan (Appendix D) will be required by EPA with additional verification from NMFS.
    vi. Large wood. Verification from NMFS will be required for any large wood placement projects that would occupy greater than 25 percent of the bankfull cross-section area
    vii. In situ or ex situ treatment of contaminated areas.

Approval conditions

The EPA will include each of the relevant project design criteria as an enforceable condition of every action authorized under this Opinion. The EPA will also include each applicable design criterion as a final action specification of every CERCLA cleanup action carried out under this Opinion.

Site access

The EPA and NMFS will retain the right of reasonable access to each project site to monitor the use and effectiveness of these conditions.

Monitoring and reporting

The EPA will ensure that the following notifications and reports (Appendix A) are submitted to NMFS for each project to be completed under this Opinion. All project notifications and reports are to be submitted electronically to NMFS at PH-CERCLA.wcr@noaa.gov, including:

a. Project notification within 60 days before the start of construction (Part 1).
b. Project completion within 60 days of the end of construction (Part 1 with Part 2 completed).
c. Fish salvage within 60 days of work area isolation with fish capture (Part 1 with Part 3 completed).

Annual program report

The EPA will submit a program implementation report to NMFS by February 15 each year that describes the EPA's efforts to carry out this Opinion. The report will include an assessment of overall program activity, a map showing the location and type of each action carried out under this Opinion, and any other data or analyses the EPA deems necessary or helpful to assess habitat trends as a result of actions covered under this Opinion. The EPA will submit reports to NMFS by email at this address: PH-CERCLA.wcr@noaa.gov.

Annual coordination meeting
The EPA will hold an annual coordination meeting with NMFS by March 31 each year to discuss the annual report and any actions that can improve conservation under this Opinion or make the program more efficient or accountable. This meeting may be held virtually or in-person. The annual report is not a substitute for the meeting.

2) General In-Water Construction PDCs

General construction measures are likely to apply to most activities to be carried out under this Opinion and are thus grouped together and presented below. Project-specific PDCs are provided in subsequent sections.

Site layout and flagging

1. Before any significant ground disturbance or entry of mechanized equipment or vehicles into the construction area, clearly flag that area to identify:
    a. Sensitive areas and ordinary high water.
    b. Equipment entry and exit points.
    c. Staging, storage, and stockpile areas.

Staging, storage, and stockpile areas

1. Designate and use staging areas to store hazardous materials or to store, fuel, or service heavy equipment, vehicles and other power equipment with tanks larger than five gallons, that are at least 150 feet from any natural water body or wetland, or on an established paved area, such that sediment and other contaminants from the staging area cannot be deposited in the floodplain or stream.
2. Natural materials that are displaced by construction and reserved for restoration, e.g., large wood, gravel, and boulders, may be stockpiled within the 100-year floodplain.
3. Dispose of any material not native to the project area, outside of the project area.
4. After construction is complete, obliterate all staging, storage, or stockpile areas, stabilize the soil if disturbed during machinery use, and revegetate disturbed areas if possible.

Erosion control

1. Use site planning and site erosion control measures commensurate with the scope of the project to prevent erosion and sediment discharge from the project site.
2. Before significant earthwork begins, install appropriate, temporary erosion controls downslope to prevent sediment deposition in the riparian area, wetlands, or water body.
3. During construction, if eroded sediment appears likely to be deposited in the stream during construction, install additional sediment barriers as necessary.
4. Temporary erosion control measures may include fiber wattles, silt fences, jute matting, wood fiber mulch and soil binder, or geotextiles and geosynthetic fabric.
5. Soil stabilization using wood fiber mulch and tackifier (hydro-applied) may be used to reduce erosion of bare soil, if the materials are free of noxious weeds and nontoxic to aquatic and terrestrial animals, soil microorganisms, and vegetation.
6. Remove sediment from erosion controls if it reaches 1/3 of the exposed height of the control.

7. Whenever surface water is present, maintain a supply of sediment control materials and an oil-absorbing floating boom at the project site.
8. Remove temporary erosion controls after construction is complete and the site is fully stabilized.

In Water Work Window

1. The current ODFW recommended in-water work window is July 1 - October 31 and December 1- January 31. ODFW may revise the windows during the course of this program to better avoid listed species since the Oregon guidelines for timing of in-water work are primarily based on the average run timing of salmon and steelhead populations and the actual timing of each run varies according to environmental conditions.
2. Minor alterations to IWWW may occur provided they are small in scope (e.g. 1-2 weeks), NMFS verifies the alteration qualifies and minor, and there is coordination with federal and state resource agencies to ensure any minor alterations to IWW are accounted for to aid in balancing the overall impact of the work to be performed (e.g., a small extension of the IWW to avoid an entire additional field season of work for a particular action may be of overall lesser impact and preferred). Minor alterations to IWWW may require mitigation.
3. All work activities should be planned to be completed within the minimum time possible between these dates and should be confined to the minimum area needed to perform the work, except as otherwise agreed upon.
4. In addition to the minor alterations described in b. above, activities that can occur throughout the year outside of an in-water work window are as follows:
    a. Sediment, pore water, and surface water collection activities — this and other types of sampling and monitoring are expected to occur throughout the year because of the limited impact to listed species expected to result from these collection activities.
    b. Collection of biota for tissue sampling activities, using strategies to limit bycatch. These strategies include selective gear types and bait appropriate for the target species. If methods are proposed that have an increased risk of bycatch (e.g., electrofishing), biota sampling would be conducted during the in-water work window to the extent possible.
    c. Transport and off-loading of sediment for upland placement disposal of dredged material at a landfill is expected to occur throughout the year owing to the limited impact expected to result from these activities.
    d. Removal and replacement of light structures such as floating docks (without pile driving/removal or other in-water excavation) and RNA no-anchor buoys are expected to occur during any period throughout the year because of the limited impact expected to result from this activity.
    e. Activities occurring in the dry or over the water are expected to occur outside of the work window with proper measures in place to prevent construction materials and equipment from entering the water.
    f. Activities occurring inside sheet pile wall containment or coffer dams that isolate the activity from the surrounding water column.

Work Area Isolation Methods and Fish Salvage

1. Engineer design plans for work area isolation to include all isolation elements and fish release areas.
2. Dewater the shortest linear extent of work area practicable, unless wetted in-river work is deemed to be minimally harmful to fish and is beneficial to other aquatic species.
    a. Use a coffer dam and a bypass culvert or pipe or a lined, non-erodible diversion ditch to divert flow around the dewatered area. Dissipate flow energy to prevent damage to riparian vegetation or the stream channel and provide safe downstream reentry of fish, preferably into pool habitat with cover.
    b. Where gravity feed is not possible, pump water from the work site to avoid re-watering. Maintain a fish screen on the pump intake to avoid juvenile fish entrainment.
    c. Pump seepage water to a temporary storage and treatment site, or into upland areas, to allow water to percolate through soil or to filter through vegetation before reentering the stream channel with a treatment system comprised of either a hay bale basin, chemical treatment system, or other control device.
    d. Monitor below the construction site to prevent stranding of aquatic organisms. When construction is complete, re-water the construction site slowly to prevent loss of surface flow downstream and a sudden increase in stream turbidity.
    e. Whenever a pump is used to dewater the isolation area and ESA-listed fish may be present, a fish screen must be used that meets current NMFS fish screen criteria (NMFS 2023). NMFS approval is required for pumping that exceeds three cubic feet per second (cfs).
3. Whenever work isolation is required and ESA-listed fish are likely to be present, attempt to capture and remove the fish as follows:
    a. If practicable, allow listed fish species to migrate out of the work area or remove fish before dewatering; otherwise, remove fish from an exclusion area as it is slowly dewatered with methods such as hand or dip-nets, seining, and trapping with minnow traps (or gee-minnow traps).
    b. Fish capture must be supervised by a qualified fisheries biologist with experience in work area isolation and competent to ensure the safe handling of all fish.
    c. Conduct fish capture activities during periods of the day with the coolest air and water temperatures possible, normally early in the morning, to minimize stress and injury of species present.
    d. Monitor the nets frequently enough to ensure they stay secured to the banks and stay free of organic accumulation.
    e. Electrofishing may be used only after other means of fish capture are determined to be ineffective or not feasible during the coolest time of day. In addition:
        i. Do not electrofish when the water appears turbid (e.g., when objects are not visible at depth of 12 inches).
        ii. Do not intentionally contact fish with the anode.
        iii. Follow NMFS (2000) electrofishing guidelines, including using only direct current or pulsed direct current within the following ranges:
            1. If conductivity is less than 100 microsiemens (µS), use 900 to 1100 volts
            2. If conductivity is between 100 and 300 µS, use 500 to 800 volts

3. If conductivity is greater than 300 μS, use less than 400 volts

f. Begin electrofishing with a minimum pulse width and recommended voltage, then gradually increase to the point where fish are immobilized.
g. Immediately discontinue electrofishing if fish are killed or injured (i.e., dark bands visible on the body, spinal deformations, significant descaling, torpidity or inability to maintain upright attitude after sufficient recovery time). Recheck machine settings, water temperature, and conductivity, and adjust or postpone procedures as necessary to reduce injuries.

Spill Response

a. Emergency response measures for certain large spills will be covered under the Northwest Area Contingency Plan for the Response to Spills of Oil and Hazardous Substances Biological Opinions (USFWS 2020, NMFS 2021).
b. All spills must be immediately reported to the Oregon Emergency Management Division's Oregon Emergency Response System and the National Response Center. Spill response kits will be kept at the work site to mitigate the impacts of any spill.

Physical Sediment Dispersion Control

a. Install sheet piling using a vibratory hammer to the maximum extent practicable.
b. Ensure sheet piling configuration does not lead to fish entrainment.
c. Allowable sheet piling materials include steel, vinyl, plastic, untreated wood, recast concrete, and fiberglass.
d. Silt curtains may be used in locations where they would be effective for sediment dispersion control
e. Moon pools may be used to control sediment dispersion where appropriate
    i. The moon pool system will consist of double-walled, near full-length turbidity curtains attached to a framework of interlocking floats enclosing a 40-foot by 40-foot work area
    ii. Steel spuds may be used to secure and stabilize the inner curtain
    iii. Moon pool curtains must be deployed to allow adequate distance between the bottom of the curtain and mudline, typically about two feet, to prevent the curtain anchors from disturbing the mudline, causing increased turbidity.
    iv. Double-walled moon pool curtains deployed from the surface can be complimented with a bedload baffle installed on the riverbed. (The bedload baffle is an anchored curtain with floatation to keep it near vertical, extending approximately 8 feet above the mudline around the perimeter of the dredging area and offset approximately 15 to 20 feet beyond the dredging area boundary to further contain any resuspended sediments during dredging.)

Vessel Operation

a. Limit boat traffic in the work area to minimize sediment resuspension.
b. Conduct boat operations in locations and manners to minimize prop wash, such as trimming up outboard/inboard motors where possible.
c. Limit boat motor revolutions per minute (RPMs) in shallower water as well as percent thrust for sea chests.
d. Optimize the size and configuration of boats utilized within specific Project Areas.
e. Educate boat operators to understand the importance of throttle control and implications of too much thrust to move a barge, scow, or while operating a vessel.
f. Position and direct prop wash to deeper waters, when possible.

3) Dredging PDCs

General Dredge Operations

a. An appropriate dredge sequencing strategy will be developed to minimize sediment with higher contamination levels from dispersing into adjacent areas.
b. Operators experienced in contaminated sediment dredging will be used for dredging activities, along with an experienced supervisor assisting them in adhering to protocols and using three-dimensional sediment visualizations.
c. Vessel draft and movement will be managed carefully within dredge areas during construction to limit the potential for scour.
d. Spuds or anchoring systems must be designed and operated carefully within contaminated dredge areas to limit the potential for resuspension of sediments.
e. The location of material removal will be confirmed using a GPS or similar device.
f. Generated water will be released pursuant to applicable discharge requirements, although SMA/project-specific cases may be identified where elutriate should not be released to surface waters.
g. Sediment resuspension shall be monitored and operations halted, if needed, to avoid excessive resuspension of sediment.
h. Develop an accurate digital terrain model of sediment contamination depth that can be viewed by the operator and supervisor.
i. Develop a dredging plan, including an over-dredge allowance, which will remove the targeted material in a single dredging event.
j. Dredge each SMA/project area to the required depth, verify with bathymetric surveys, and cover with a residual management layer.
k. Ensure accurate bucket placement by using GPS located on the bucket with sub-foot accuracy.
l. Use stair-step dredge cuts to reduce sediment sloughing along steeper slopes.

Mechanical Dredging

Project designers will determine the use of PDCs in remedial design based on water quality monitoring and other SMA/project-specific factors.

a. Use a closed or environmental bucket. This technology consists of specially constructed dredging buckets designed to reduce or eliminate increased turbidity in the water column. Environmental buckets are not suitable in certain situations, including situations with sediments of medium or greater density or in areas with substantial debris, which can prevent the bucket from closing correctly. If not properly used, environmental buckets can exacerbate sediment resuspension in some situations. Where debris is prevalent and bucket closures are unsuccessful, a heavier, digging bucket and/or a debris clearance program may be pursued as determined by the EPA in consultation with NMFS.
b. Properly select the dredge bucket for site conditions (i.e., soft sediment versus debris and/or hard digging). If multiple “bites” are taken and the bucket cannot close, consider changing from an environmental bucket to a different type to minimize short-term impacts (e.g., change to a bucket suitable for debris until it is cleared and then switch back to the environmental bucket).
c. Avoid taking multiple bites with the bucket to reduce sediment resuspension. The practice of multiple bites involves repetitive lowering, raising, and reopening the bucket to obtain a fuller sediment load.
d. Prevent sweeping or leveling by pushing bottom sediments around with dredge equipment to achieve required elevations or to detect high spots. Similarly, avoid swinging the bucket over the bottom sediments to look for “high spots.” Dredging of holes or sumps below the maximum depth and redistribution of sediment by dredging, dragging, or other means is prohibited.
e. Prevent interim in-water stockpiling of dredged material. Avoid stockpiling silty dredge material on the river bottom.
f. Implement bucket control techniques such as not overfilling the bucket, closing the bucket as slowly as possible on the bottom, pausing before hoisting the bucket off of the bottom to allow any overage to settle near the bottom, and hoisting the load very slowly. Ensure production rate targets do not interfere with these control techniques and required pauses.
g. Once out of the water, the bucket should be moved quickly to the barge. Do not allow the bucket to drip over water before placement in the barge.
h. Confirm that all the material has been placed into the barge from the bucket before returning the bucket to the water to take another bite of material by “slamming” open the bucket after material is dumped on the barge to dislodge any additional material potentially adhering to the bucket and/or rinsing the bucket at the barge to clean off excess sediment between loads. Dumping of partial or full buckets of dredged material back into the river is prohibited.
i. Require a debris sweep prior to dredging in known debris areas (debris caught in dredging equipment can cause additional resuspension and release of contaminated sediments).
j. Minimize the potential for slope failures by maintaining stable side slopes during dredging (e.g., shallow top-to-bottom cuts).
k. Limit operations during relatively high-water velocity conditions (turbulence near the dredge bucket during high-flow conditions can cause additional resuspension and release of contaminated sediments).

l. At the end of a work shift, do not clean the bucket at the water surface by dunking. Clean the bucket on the barge where rinse water may be controlled and treated as needed.
m. Perform water quality monitoring in accordance with site-specific plans. The details of water quality monitoring will vary with EPA-approved water quality monitoring plans (WQMPs). A typical approach is that if an exceedance of water quality criteria (as defined by the WQMP) is detected during mechanical dredging, a sequence of responses will be initiated, including the implementation of additional controls to be determined as needed. The details and sequence of the steps will be developed during remedial design.
n. Examples of possible operational responses that could be implemented if water quality criteria are exceeded on specific mechanical dredging projects as determined in remedial design include the following:
    - Slow the dredge cycle time, if necessary, including:
        - Decrease the velocity of the descending empty bucket through the water column, which reduces the potential to overfill the bucket and reduces the potential for sediment resuspension owing to the bucket hitting the river bottom.
        - Pause the bucket at the bottom before hoisting the bucket through the water column to allow any overage to settle near the bottom.
        - Close the bucket more slowly on the bottom.
        - Reduce the velocity of the ascending loaded bucket through the water column, which reduces the potential to wash sediment from the bucket and the sediment loading into the water column over a set period.
    - Reduce the amount of material in each bucket load. Avoid overfilling.
o. Avoid the release of turbid water into the river by removing excess water from sediment barges during dredging by pumping the water and collecting it for transfer to a transload facility or barge for treatment.
p. If modifications to dredge operations fail to address water quality exceedances, additional measures may be required (e.g., additional dewatering, treatment, or modifications to engineering controls such as silt curtains.)
q. Additional modifications to conventional mechanical dredging equipment based on Site-specific conditions may include (ITRC 2014):
    - Fitting the crane with a longer boom (arm) for additional reach during dredging
    - Fitting an excavator with a longer arm for better access
    - Using a fixed-arm bucket instead of a cable-suspended bucket to increase the accuracy and precision of cuts and provide greater bucket penetration in stiffer materials
    - Equipping the bucket with hydraulically operated closure arms to reduce bucket leakage
    - Installing a sediment dewatering and water collection and treatment facility on the barge or at a temporary staging site
    - Installing GPS or other bucket monitoring equipment to provide the equipment operator with precise coordinate control of the bucket during

dredging operations and real-time, three-dimensional visualization of the dredge prism

Hydraulic Dredging

Hydraulic dredging may result in more water quality impacts than mechanical dredging because a portion of the turbid water and slurry (a "spillage" layer) is left behind and may be released to the water column (Fuglevand and Webb 2012). Hydraulic dredges are also not capable of removing debris, so mechanical dredging equipment must first be used for debris removal.

a. During hydraulic dredging, the cutter head should, in most instances, be maintained in the substrate and not be raised more than three feet above the river bottom when the dredge pumps are running to minimize entrainment of fish. Operate just below the sediment surface to avoid exposure of blades or cutting too deep.
b. Perform water quality monitoring in accordance with the WQMP. As mentioned above for mechanical dredging, the details of water quality monitoring will vary with the WQMP. A typical approach is that if an exceedance of water quality criteria is detected during hydraulic dredging, a sequence of responses will be initiated, including the implementation of additional controls to be determined as needed. The details and sequence of the steps should be developed and presented during remedial design.
c. Examples of possible operational responses that could be implemented if water quality criteria are exceeded on specific hydraulic dredging projects include the following:
    i. Reduce cutterhead rotation speed. Reducing cutterhead rotation speed reduces the potential for side-casting the excavated sediment away from the suction entrance and resuspending sediment.
    ii. Reduce swing speed. Reducing the swing speed ensures that the dredge head does not move through the cut faster than it can hydraulically pump the sediment. Reducing swing speed reduces the volume of resuspended sediment. The goal is to swing the dredge head at a speed that allows as much of the disturbed sediment as possible to be immediately removed with the hydraulic flow. Typical swing speeds are five to 30 feet per minute.
    iii. Eliminate bank undercutting. Removing sediment in maximum lifts equal to 80 percent or less of the cutterhead diameter reduces potential for side sloughing.
    iv. Increase pump rates to provide more suction.
d. Backhoes can be modified or equipped with covers for the bucket to improve retention of the sediment and to minimize resuspension.
e. Utilize precision dredging when possible: Dredging utilizing special tools and techniques to precisely restrict the work area boundaries only to those areas specifically identified for dredging. This may mean thin layers or precise prism boundaries.

4) Barge Loading and Transport PDCs

a. A double-hulled bin-barge or flat-deck barge with watertight sideboards and cover, or other similar measures, should be used to enclose dredged material, including dredged sediment and water, to prevent material from leaking from the bins or overtop the walls of the barge.

b. Barges used to contain and transport dredged sediment will be monitored to prevent over-filling, overflow, and/or direct discharge to the waterbody. Water from dredged material will be routed to barge- and/or land-based water management systems designed to remove excess sediment and associated contaminants based on water quality criteria established in the WQMP.
c. Treated barge return water may be discharged to the waterbody if treatment occurs within 150 feet of the active dredge, and per the requirements outlined in the WQMP and CWA 404 ARAR Memo. Project-specific cases may be identified where return water or elutriate should not be discharged to the waterbody.
d. Barges will be visually inspected for any sediment adhered to the sides of the barge that could enter the river during transport. Contractor personnel will remove any such sediment and place it inside the barge before the barge leaves the work area.
e. Barges leaving the area where remedial activities are being conducted will be sealed so that no discharge of water or suspended sediment occurs in the receiving waters.
f. Barge transport operations will be confined to designated transit routes.
g. Barges in transit will be periodically inspected and may be required to be covered if windblown material is observed.

5) Capping and Treatment PDCs

Placement of Materials for Capping, In Situ Treatment, ENR, and Residual Management

a. Materials for placement into the Site should be tested for ROD (Table 17) riverbank soil/sediment COCs at a rate of approximately one sample per 500 cubic yards (to be finalized during remedial design) and be below CULs.
b. The placement of material should generally start at lower elevations and work to higher elevations.
c. Set volume, tonnage, lead line measurements, and bathymetry information or similar should be used to confirm adequate and complete coverage of the target area during and following material placement.
d. Perform placement in shifts to minimize disturbance of each placement, lower the amount of residuals in the top most layers of the cap most accessible by the benthic community, and minimize cap depth variability.
e. Perform water quality monitoring in accordance with the WQMP. If an exceedance of water quality criteria is detected during any type of in-place technology construction activity, a sequence of responses should be initiated according to the WQMP, including implementing additional controls to be determined as needed. The details and sequence of the steps should be developed and presented during remedial design.
f. Perform material placement during the approved in-water work window and when river currents are relatively low.
g. Employ physical barriers (e.g., silt curtains, sheet piles), as appropriate, based on site conditions to control suspended sediments.
h. If a turbidity exceedance occurs, placement activities should be progressively slowed or halted until turbidity exceedances are no longer detected outside of the compliance

boundary. Following modifying placement methods to prevent turbidity exceedances, monitoring should continue, and operations should be modified as indicated in the terms of the WQMP.

i. Residuals (contaminated sediments remaining in or adjacent to the footprint after dredging is completed) (Palermo et al. 2008), must be controlled using the following methods:
    i. Confirm that all materials targeted for dredging have been removed for each dredge management unit and place the dredge residuals cover layer as soon as possible to limit the release of contaminants. The cover layer should be applied as soon as practicable after the design dredge elevation has been met. A 12-inch layer is assumed for all dredge areas to control residuals and releases.
    ii. Sand should be clean material that satisfies applicable design specifications and meets appropriate ROD Table 17 criteria. Imported materials should consist of clean, granular material free of roots, gross organic material, contaminants, and all other deleterious material. Having some level of organic carbon is preferred as this can help bind contaminants and lower their bioavailability (EPA 2017b).
    iii. In areas where principal threat waste (PTW) is present, five percent activated carbon will be mixed with the residual layer.
    iv. Sediment cores and/or "rain buckets" are assumed to be taken through the post-dredge sand layer to confirm the required layer of sand has been applied to manage residuals. These cores will be taken once the sand layers have been applied.

j. Apply an engineered beach mix layer consisting of rounded gravel, typically 2.5 inches or less (or other appropriate native material as determined during project-specific remedial design) to the uppermost layer of all caps and dredge leave surfaces in riverbank and shallow areas. Beach mix should not be applied to leave surfaces consisting of sand unless required owing to changes in hydrodynamic conditions following remedial activities. If beach mix is placed over riprap armoring, monitoring would be required to determine whether the site-specific conditions are conducive to maintaining the beach mix habitat layer over the riprap.

k. A monitoring plan must be included with the proposed action plan. The monitoring plan shall include frequency and duration of monitoring, which will depend on the location and constituent nature of capping configuration and fill material. Hydrographic and physical monitoring of caps and beach mix habitat layers will be required at time zero; at years 1, 3, and 5; and every 5 years after that as part of Five-Year Reviews. Monitoring will also be required following a significant event such as a flood, earthquake, or vessel/debris grounding. Hydrographic monitoring will entail bathymetric surveys and/or topographic surveys. Physical monitoring may entail methods such as diver surveys, probing/poling, or sub-bottom profiling. Caps must be monitored for the life of the contaminated material, and beach mix shall be monitored to ensure the layer is 6 inches thick. The monitoring plan shall include response proposals to address shifting beach mix, inadvertent uncovering or resuspension of contaminated material, or any circumstance that results in loss of beach mix or cap function. If monitoring or site-specific modeling demonstrate that a sand/gravel surface can be maintained long term, this may be considered by the EPA when determining if the compensatory mitigation proposed during remedial design is adequate.

l. For in-situ stabilization (ISS) these measures apply:
    i. Mechanical and operational measures, including the following (Jansen et al. 2016):
        - Control turbidity, sheen, and pH with the use of a turbidity curtain system or similar method.
        - Reduce turbidity and disruption of the upper sediment surface by using auger weight or low rotational speeds to advance through the first 2 to 3 feet of sediment.
        - Evaluate operations during relatively high-water velocity conditions relative to the silt current containment design.
    ii. Examples of possible operational responses that could be implemented if water quality criteria are exceeded on specific in situ treatment projects include the following (Jansen et al. 2016):
        - Follow quality assurance procedures to confirm the following:
            - Grout mixture meets design specifications.
            - Volume of grout injected into each column meets design values.
            - Auger rotation speed, grout injection flow rate, rotary head pressure, depth, column overlap, vertical alignment, and time to perform the column are within project targets.
        - Adjust operation parameters (e.g., reduce the auger rotation speed or reduce penetration and withdrawal speed) to reduce water quality exceedances.
        - Adjust the volume of cement grout injected into each column.
        - Reduce the water-to-grout ratio to reduce swell.
    iii. Require a debris sweep prior to beginning work in known debris areas (debris caught in in situ treatment equipment can cause additional resuspension and release of contaminated sediments).
    iv. Ensure that the cement grout mixture achieves the following (Jansen et al. 2016):
        - Properly selected for site conditions based on site-specific bench-scale and field pilot testing
        - Properly selected to meet testing requirements for unconfined compressive strength, hydraulic conductivity, and leaching
    v. Perform water quality monitoring in accordance with the WQMP.

6) Piling Installation and Removal PDCs

Piling Removal

a. Use the following steps to minimize creosote release, sediment disturbance, and sediment resuspension:
    i. Prior to start of work, the project engineer or contractor should assess the condition of the piling and identify whether it will be removed using a barge

or upland equipment. The contractor's work plan must include procedures for extracting and handling pilings that break off during removal. In general, complete extraction of all pilings is preferable to partial removal.

ii. When possible, removal of treated wood pilings should occur in the dry or during low water conditions. Doing so increases the chances that the pilings will not be broken (greater visibility by the operator) and increases the chances of retrieval if pilings are broken.

iii. The crane operator shall remove pilings slowly to will minimize turbidity in the water column and sediment disturbance.

iv. The operator shall minimize overall damage to treated wood pilings during removal. In particular, treated wood pilings must not be broken off intentionally by twisting, bending, or other deformation. This will help reduce the release of wood-treating compounds (e.g., creosote) and wood debris to the water column and sediments.

v. Upon removal from the substrate and water column, pilings shall be moved expeditiously into the containment area for processing and disposal at an approved off-site, upland facility.

vi. Pilings shall not be shaken, hosed-off, stripped, scraped off, left hanging to drip, or any other action intended to clean or remove adhering material from the pilings. Any sediment associated with the removed pilings must not be returned to the waterway. Adhered sediments associated with treated pilings are likely contaminated and may, along with the pilings, require special handling and disposal.

vii. The operator shall make multiple attempts to remove a piling before resorting to cutting.

b. Vibratory extraction is the preferred method of piling removal because it causes the least disturbance to the riverbed, and it typically results in the complete removal of the piling from the aquatic environment.

    i. The operator should "wake up" the piling by vibrating it to break the skin friction/suction bond between the piling and sediment. This bond breaking avoids pulling out a large block of sediment and possibly breaking off the piling in the process.

c. Direct pull extraction refers to removing a piling via crane or other large machinery by grabbing or wrapping the piling and then directly pulling it from the sediment.

    i. Excavation of sediment from around the base of a piling may be required to gain access to sound portions of the piling and to allow for extraction using direct pull methods.

    ii. Excavation may be performed in the dry at low tide or in the water using divers. Hydraulic jetting devices should not be used to move sediment away from pilings to minimize turbidity and releases to the water column and surrounding sediments.

d. Clamshell removal of a piling uses a barge-based or upland excavator-mounted clamshell bucket.

i. To the extent possible, clamshell extraction should be performed in the dry during low tide, low river flows, or reservoir drawdown. Under these conditions, the operator can see the removal site and piling, improving the chance for full removal of the piling.
ii. Every effort should be made to properly size the bucket to the job and operate it in ways that minimize sediment disturbance.
iii. Excavation may be performed in the dry at low tide or in the water using divers.
iv. Hydraulic jetting devices should not be used to move sediment away from pilings to minimize turbidity and releases to the water column and surrounding sediments.
v. An offshore boom must be in place with this removal technique to contain debris. If treated wood pilings are being removed, extracted pilings shall be transferred to the containment basin without leaving the boomed area to prevent loss of treated wood chemicals (e.g., creosote) and debris to the water column and sediments.
vi. The operator must minimize pinching of treated wood and overall damage to treated wood pilings during removal.
vii. Grubbing for broken pilings is prohibited.

Piling Removal for Locations with Contaminated Sediments

a. During project planning, consider the best tidal condition for piling removal. For example, in some circumstances, water access for removal equipment at high tide may be less disturbing to the sediment than access in the dry at low tide. In others, removal in the dry is the best option.
b. Based on the EPA's experience at numerous Superfund cleanup sites (e.g., Pacific Sound Resources, Olympic View, Ketchikan Pulp Mill, Lockheed), extraction of pilings is not expected to result in exposure to subsurface contaminated sediments via an exposed hole. Therefore, NMFS does not require placement of sand prior to or after piling removal unless it is part of an overall project design, such as a cap. Undocumented placement of clean sand may complicate future characterization efforts at cleanup sites.
c. If piling removal results in exceedance of turbidity or other water quality criteria at the compliance boundary, reconsider the timing of removal to a more restricted time frame, for example, the lowest practical tide condition or around slack water.
d. Cutting a piling will be considered a last resort following multiple attempts to fully extract the piling using vibratory, direct pull, and/or clamshell bucket extraction. On a project-specific basis, cutting a piling may be appropriate to maintain slope stability or if a piling is broken and cannot be removed by other methods.
    i. A pneumatic underwater chainsaw, shearing equipment, or other equipment should be used to cut a piling.
    ii. Pilings shall be cut below the mudline, with consideration given to the mudline elevation, slope, and stability of the site.
    iii. In intertidal and shallow subtidal areas (shallower than -10 feet mean lower low water [MLLW] or approximately -8.35 CRD at the Site), seasonal accretion and erosion of the nearshore and/or beach can expose cutoff piling.

In these locations, pilings should be cut off at least two feet below the mudline. In deeper subtidal areas (deeper than -10 feet MLLW or approximately -8.35 CRD at the Site), pilings should be cut off at least one foot below the mudline.

iv. To minimize turbidity and releases to the water column and surrounding sediments, hydraulic jetting devices shall not be used to move sediment away from piling.

v. The performing party will be required to provide a post-construction drawing/map to the EPA and USACE for the administrative record, which shows the location and number of pilings left in place (above and below the mudline) with the GPS locations in North American Datum of 1983. The performing party will also provide this information to the property owners.

Cutting pilings in locations with contaminated sediments:

a. Complete removal of a piling from the environment is preferred. When necessary, project-specific requirements (including equipment selection) for cutting shall be set by the project engineer and coordinated with the EPA and any other appropriate resource agencies, considering the mudline elevation, slope, and stability of the site and the condition of the piling.
b. If cutting is required, the appropriate depth below the mudline for cutting should be made on a project-specific basis, with the goal to minimize both the resuspension of contaminated sediments and release of wood treatment chemicals.
c. If cutting is required, a sand cover should be placed on top of the cut pile, consisting of a minimum of six (6) inches of clean sand at a 15-foot radius around each pile/group of piles.
d. For projects with derelict treated piling stubs that cannot be removed, consideration should be given to either leaving these in place or, if possible, cutting them below the mudline. Cutting the piling at the mudline may release PAHs into the water column. If a sand cover is placed over the cut piling, this may help contain the PAHs; however, the new sediment may move over time and the piling may be exposed again.
e. The decision to leave pilings in place that were initially slated for removal must be coordinated with the EPA and any other appropriate resource agencies. For example, if the work is being performed as part of a state or federal cleanup, the decision to leave pilings in place, and its documentation, must be coordinated with the agency with cleanup oversight and the property owner.

Piling Removal – Debris Control

a. All work should be confined to within a floating containment boom. The need for, type, and size of the boom should be determined on a project-specific basis considering project size, habitat, water flow conditions, sediment quality, etc. A description of boom placement and management must be included in the programmatic ESA review request. A small boat should be available at all times during active construction to manage the boom and captured debris. If used, anchors must be removed once the project is complete.

b. For projects removing pesticide-treated wood structures, the following conditions apply:
    i. Ensure that, to the extent possible, no wood debris falls into the water. If wood debris does fall into the water, remove it immediately.
    ii. A floating boom with absorbent pads must be installed to capture floating surface debris and any creosote sheen.
    iii. The boom shall be located at a sufficient distance from all sides of the structure or piling being removed to ensure contaminated materials are captured.
    iv. Extracted pilings shall be transferred to the containment basin without leaving the boomed area to prevent loss of treated wood chemicals (e.g., creosote) and debris to the water column and sediments.
    v. The boom shall stay in its original location until any sheen present from removed piling has been absorbed by the boom or removed utilizing absorbent material.

c. Any shavings, sawdust, woody debris (splintered wood, fragments, loose piling) on the water or sediment surface must be retrieved and placed in the containment area. Likewise, any piling-associated sediment and adhered organisms must be collected daily, contained on-site, and ultimately disposed of at an approved upland disposal site, along with the extracted piling and decking.

d. When asphalt or other decking is removed, the contractor shall prevent asphalt grit or other debris on the pier from entering the water. Prior to demolition, the contractor shall remove as much of the surface asphalt grit and debris as possible.

e. Floating platforms, suspended tarps, or other means should be deployed under and around the structure to capture grit and debris. If possible, remove such material when the area below is dry to allow easier collection of dropped materials via tarps, etc.

Piling storage and handling

a. Upon removal from the substrate, the piling and associated sediments shall be moved expeditiously from the water into a containment area on the barge deck, adjacent pier, or upland area.

b. The containment area shall be constructed in such a fashion as to restrict any release of contaminants or debris to the aquatic environment. Containment areas on barges, piers, and upland areas shall have continuous sidewalls and controls as necessary (e.g., straw bales, oil absorbent boom, ecology blocks, durable plastic sheeting or lining, covers) to contain all sediment, wood-treating compounds, organisms and debris, and to prevent the reentry of these materials into the aquatic environment. Barges will be double-hulled when handling contaminated materials.

c. Any floating debris, splintered wood, or sediment removed during piling removal must be placed in a containment area.

d. Piling and associated sediments, construction debris/residue, and plastic sheeting from the containment basin shall be removed and disposed in accordance with applicable federal and state regulations. For disposal, this will require shipment to an approved Subtitle D landfill.

e. Pre-project planning shall include measures to minimize water contact with pilings and associated contaminated sediments. For example, the containment area can be designed to be covered during precipitation and when not in use, and/or pilings and associated sediments can be quickly moved to a final disposal location and not retained at the project site.

f. Water collected in a containment area may require special management or treatment depending on project specifics. In some cases, water may be stored in containers (e.g., Baker tanks) and treated off-site. In others, a treatment system may be constructed on-site. Discharge water must meet the requirements of CWA and associated ARARs, as outlined in Tables 25a-c of the ROD (see Appendix B), including the requirements of an NPDES permit (or substantive requirements), with consideration of CWA Section 303(d) listed areas to discharge to surface water.
g. Perform water quality monitoring in accordance with the WQMP. If an exceedance of water quality criteria is detected during any type of in-place technology construction activity, a sequence of responses should be initiated according to the WQMP, including implementation of additional controls to be determined as needed. The details and sequence of the steps should be developed and presented during remedial design.

Piling Placement

a. Pilings may be made of steel, concrete, plastic, or untreated wood. Pilings may be around 36 inches in diameter or smaller, or steel H-pile designated as HP24 or less. Wood, concrete, steel, or plastic pilings may be installed using vibratory methods and/or an impact hammer. Vibratory methods are typically preferred as they reduce impacts to fish listed under ESA, though this method may be combined with an impact hammer for proofing. BMPs for pile driving with an impact hammer are provided below.
b. Hydraulic jetting devices will not be used to place pilings.
c. When a piling is being repaired using splicing or other methods, the contractor shall prevent the introduction of construction-related materials into the aquatic environment. For example, wet concrete must be prevented from entering waters of the state, and forms/sleeves made of impervious materials must remain in place until concrete is cured.
d. When a maintenance or repair method requires cleaning of a piling (e.g., removal of encrusting organisms), any removed material must be captured and disposed of upland.
e. When steel or plastic pilings are being reused in the aquatic environment, any sediment adhered to a piling or remaining inside of hollow piling must first be removed and disposed of upland at an appropriate location. Creosote-treated pilings may not be reused.
f. When proposing to reuse piling, the performing party must evaluate whether there is the potential to transport invasive species from the source area and must ensure their complete removal so that there is no opportunity for transport/transfer of invasive species.
g. All pilings, mooring buoys, and navigational aids must be fitted with devices to prevent perching by piscivorous birds.
h. Vibratory hammer must be used for pile installation to maximum extent practicable.

i. When using an impact hammer to drive or proof steel pilings, one of the following sound attenuation methods must be used:
    i. Completely isolate the piling from flowing water by dewatering the area around the piling.
    ii. If water velocity is 1.6 feet per second or less, surround the piling being driven by a confined or unconfined bubble curtain (Wursig et al. 2000, Longmuir and Lively 2001) that will distribute small air bubbles around 100 percent of the piling perimeter for the full depth of the water column.
    iii. If water velocity is greater than 1.6 feet per second, surround the piling being driven by a confined bubble curtain (e.g., a bubble ring surrounded by a fabric or non-metallic sleeve) that will distribute air bubbles around 100 percent of the piling perimeter for the full depth of the water column.

j. Perform water quality monitoring in accordance with the WQMP. Containment mobilization from the bubble curtain must also be monitored at this time. If an exceedance of water quality criteria is detected during any type of in-place technology construction activity, a sequence of responses should be initiated according to the WQMP, including the implementation of additional controls to be determined as needed. The details and sequence of the steps should be developed and presented during remedial design.

k. Sheet pile or pile driving is limited to up to three projects occurring concurrently.

7) Riverbank Construction and Stabilization PDCs

a. Keep equipment out of the water to the extent possible. It is assumed that land-based excavators would be used for removal of riverbank materials in locations above water.

b. Complete riverbank construction in the late summer and early fall when the river stage is low.

c. Incorporate the following measures during the placement of large rock:
    i. Place material with consideration for existing hydraulic forces interfacing with beach areas. The goal should be to place material at locations where river flows push material onto and along beach areas to encourage deposition and stability.
    ii. Use only clean, erosion-resistant rock from an upland source. No broken concrete or asphalt shall be used.
    iii. Place armor rock by using a land-based excavator positioned at top of bank, by barge-mounted crane, or by hand. Dumping of rock is prohibited, such as dumping from the end of a dump truck.
    iv. Do not overfill the bucket which could lead to misplacement of rock.

d. Isolate the work area to minimize impacts to in-water habitat.

e. Any action that will require earthwork and may increase soil erosion and cause runoff with visible sediment into surface water, or that will require the use of materials that are hazardous or toxic to aquatic life (such as motor fuel, oil, or drilling fluid), must have a pollution and erosion control plan.
    i. The plan must include practices to minimize erosion and sedimentation associated with all aspects of the project (e.g., staging areas, stockpiles,

grading) to prevent construction debris from dropping or otherwise entering any stream or waterbody and prevent and control hazardous material spills.

ii. If monitoring shows the erosion controls are ineffective at preventing visible sediment discharge, the project must stop to evaluate erosion control measures. Repairs, replacements, or the installation of additional erosion control measures must be completed before the project resumes.

iii. Erosion controls and BMPs described in the pollution and erosion control plan should include:

- Before significant earthwork begins, install appropriate, temporary erosion controls downslope to prevent soil deposition in the water body. Temporary erosion control measures may include fiber wattles, silt fences, jute matting, wood fiber mulch and soil binder, or geotextiles and geosynthetic fabrics.
- During construction, if eroded soil appears likely to be deposited in the water body during construction, additional sediment barriers should be installed as necessary.
- Remove soil and debris from erosion controls (e.g., silt fences or hay bales) if it reaches one-third of the exposed height of the control.
- Remove temporary erosion controls after construction is complete and the site is fully stabilized.
- Erosion control measures are assumed to either divert surface water flows/runoff around and away from excavations or limit off-site transport of eroded riverbank materials.
    - Sheet piles can be used to isolate ongoing excavations from erosive hydrodynamic forces if the river stage increases during excavation.
    - Permeable berms (e.g., straw wattles) can be used if sheet piles are not feasible.
- Soil stabilization using wood fiber mulch and tackifier (hydro-applied) may be used to reduce erosion of bare soil if the materials are free of noxious weeds and are nontoxic to aquatic and terrestrial animals, soil microorganisms, and vegetation.
- Revegetation of disturbed riverbanks should include the following:
    - Plant and seed disturbed areas before or at the beginning of the first growing season after construction.
    - Use species that will achieve shade and erosion control objectives, including forb, grass, shrub, or tree species that are appropriate for the site and native to the project area or region.
    - Short-term stabilization measures may include use of non-native sterile seed mix if native seeds are not available, weed-free certified straw, jute matting, and similar methods.
    - When feasible, use vegetation salvaged from local areas scheduled for clearing because of development.
    - Do not apply surface fertilizer within 50 feet of any wetland or water body.

- Install fencing, as necessary, to prevent access to revegetated sites.
    - Do not use invasive or non-native species for site restoration.
    - Remove or control invasive plants until native plant species are well-established.
- Employ dust abatement measures as necessary.
- Maintain a supply of sediment control materials and an oil-absorbing floating boom at the project site.

f. The following streambank stabilization methods may be used individually or in combination:
   i. Large wood placement
   ii. Vegetated riprap with large wood
   iii. Roughened toe
   iv. Woody plantings
   v. Herbaceous cover in areas where the native vegetation does not include trees or shrubs
   vi. Bank reshaping and slope grading
   vii. Coir logs
   viii. Deformable soil reinforcement
   ix. Floodplain flow spreaders
   x. Floodplain roughness

g. Large Wood (LW) Placements are defined as structures composed of LW that do not use mechanical methods as the means of providing structure stability (i.e., large rock, rebar, rope, cable, etc.). The use of native soil, alluvium with similar angularity as the natural bed material, large wood, or buttressing with adjacent trees as methods for providing structure stability are authorized. This method is not generally applied to mainstem systems; however, within the Portland Harbor, there may be areas and opportunities to use this type of streambank stabilization method, which also add habitat complexity. These structures are designed to provide roughness, redirect flow, and provide stability to adjacent streambed and banks or downstream reaches, while providing valuable fish and wildlife habitat.
   i. NMFS will verify any LW placement projects that would occupy greater than 25 percent of the bankfull cross-section area.
   ii. Structures may be positioned along river banks.
   iii. Structures will incorporate a diverse size (diameter and length) distribution of rootwad or non-rootwad, trimmed or untrimmed, whole trees, logs, snags, slash, etc.
   iv. Consider orienting key pieces such that the hydraulic forces upon the LW increase stability.

h. Vegetated riprap with LW will be installed as follows:
   i. When present, use natural hard points, such as large, stable trees rock outcrops, to begin or end the toe of the revetment.
   ii. Develop rock size gradations for elevation zones on the bank, especially if the rock will extend above OHW – the largest rock should be placed at the toe of the slope, while small rock can be used higher in the bank where the shear

stress is generally lower. Most upper bank areas will not require the use of any rock but can depend on the vegetation for erosion protection.

iii. For bank areas above OHW where rock is still deemed necessary, mix rock with soil to provide a better growing medium for plants.

iv. Minimum amount of wood incorporated into the treated area, for mitigation of riprap, is equal to the number of whole trees whose cumulative summation of rootwad diameters is equal to 80 percent of linear-feet of treated streambank or 20 percent of the treated area (square feet) of streambank, whichever is greater.

v. Where whole trees are not used (i.e., snags, logs, and partial trees) designers are required to estimate the dimensions of parent material based on rootwad diameter, and calculating a cumulative equivalency of whole trees.

vi. LW should be distributed throughout the structure (not just concentrated at the toe) to engage flows up to the bankfull flow. LW placed above the toe may be in the form of rootwad or non-rootwad, trimmed or untrimmed, whole trees, logs, snags, slash, etc. Maximize the exposure of wood to water by placing and orienting wood to project into the water column up to the bankfull elevation.

vii. Develop an irregular toe and bank line to increase roughness and habitat value.

viii. Use LW and irregular rock to create large interstitial spaces and small alcoves to create planting spaces and habitat to mitigate for flood-refuge impacts. Do not use geotextile fabrics as a filter behind the riprap whenever possible; if a filter is necessary to prevent sapping, use a graduated gravel filter.

ix. Structure toe will incorporate LW with intact rootwads. Minimum spacing between rootwads placed at the toe will be no greater than an average rootwad diameter.

x. LW placed at the toe will be sturdy material, intact, hard, and undecayed and should be sized or embedded sufficiently to withstand the design flood.

xi. Space between root wads may be filled with large boulders trimmed or untrimmed, whole trees, logs, snags, slash, etc. When used, diameter of boulders placed between toe logs with rootwads should be 1.5 to 2.0 times log diameter at breast height (dbh) of adjacent toe logs. A reasonable maximum rock size is 5-6 feet in diameter.

xii. Plant woody vegetation in the joints between the rocks to enhance streambank vegetation.

i. Where possible, use terracing or other bank shaping to increase habitat diversity and create less steep slopes (5:1 or shallower).

j. When possible, create or enhance a vegetated riparian buffer.

k. Monitor vegetated riprap each year following installation by visual inspection during low flows to examine transitions between undisturbed and treated banks to ensure that native soils above and behind the riprap are not collapsing, sinking, or showing other evidence of piping loss or movement of rock materials; and the overall integrity of the riprap treatment, including:

i. Loss of rock materials

ii. Survival rate of vegetation
iii. Anchoring success of LW placed in the treatment.
iv. Any channel changes since construction.

l. Roughened toe
    i. Where designs use any of the approved streambank stabilization methods in this section, in lieu of lining the bank with riprap above the toe design of any rock-filled toe will constructed so that material should be placed in a manner that mimics attached longitudinal bars or point bars; and size distribution of toe material will be diverse and predominately comprised of D_{84} to D_{max} size class material.

m. Vegetated riprap with large wood.
    i. Minimum amount of wood incorporated into the treated area, for mitigation of riprap, is equal to the number of whole trees whose summation of rootwad diameters is equal to 80 percent of linear feet of treated streambank.

8) Transload Facilit(ies)y Operation PDCs

a. In the event of high river flows, storms, or high wave conditions, transload operations may be limited or suspended at the transload facility.
b. There will be no dewatering from the barge to the river at the transload facility.
c. Improvements at the transload facility will include paving and sealing existing joints and transitions in the roadway. Wharf decking and all surfaces that can come in contact with dredged sediments and associated water must be made of solid (no slats) impermeable materials. Extruded asphalt curbing will be installed to corral precipitation and add a redundant mechanism to isolate potential spillage in the transloading process. If rainwater accumulates, it will be pumped from the wharf area.
d. Sheeting or some type of impermeable lining must be placed under the travel area of the bucket to capture any spills. Spills outside of the area covered by the sheet will be cleaned up immediately. Dockside sediment control (e.g., sweeper truck, shoveling, sweeping, wash down) shall occur as often as necessary to avoid the tracking of sediment by vehicles and personnel and generally maintain a clean site and shall include the dock, transload area, and the haul routes. A spotter will be present at all times to check that there is no leakage in bucket before transferring material from barge. Drying agent materials will be staged in a containment area within reach of the load-out excavator with appropriate controls to contain any stormwater runoff and spillage.
e. A fully-welded, watertight steel fabricated box will be used to provide a large target for the equipment used to transfer the sediments to on-highway, 8-axle trucks and trailers, or railcars. The walls of the box will be of sufficient height to eliminate the potential of splattering sediment outside of the containment to the sides of trucks or the transfer pad as the transfer bucket opens. Transfer of dredged material should occur in a fashion that minimizes splash and splatter of the material.
f. The transloading equipment must have a spill apron deployed between the barge and shore during off-loading operations to prevent the release of spilled material into the water.

i. The apron must be made of impermeable material and not have seams that would allow leakage into the water.
ii. The apron will collect material dripped from the rehandling equipment, including rainfall, and route it back into the barge or into a dock-side containment structure.
iii. The spill apron must be wide enough that material will not fall off the sides and may include wing walls to increase the level of protection.
iv. Material shall not be allowed to accumulate on the spill apron.
v. Containment measures (e.g., straw bales/wattles, filter fabric) should be used to capture water running down the apron.
vi. The apron must be able to track up and down with the barge during tidal fluctuations to prevent the separation of the apron from the barge.

g. Before moving the crane/excavator, the spill apron and bucket must be decontaminated with a pressure washer, and the water captured and contained. Wash water will not be left on the barge. Alternatively, the transload setup may include dedicated unloading equipment that would remain at the transload dock.
h. During setup of the transload facility(ies)y, bed liners will be shipped and stored, the
    i. lining and truck/railcar bed covering stations will be constructed, and the truck/rail
    ii. haul routes (temporary pavement markers) will be established. Prior to load-out in
    iii. the trucks/railcars, each bed will be fully lined with plastic before the sediments are
    iv. loaded. Upon completion of loading the trucks/railcar, each truck/railcar bed will be
    v. covered prior to departure to the landfill. If sediment spillage occurs at the transfer
    vi. point, the material will be immediately hand-shoveled, swept up, and incorporated
    vii. into the load.
i. Loading of the truck/railcars will take place within an exclusion zone, which will be established to contain any spilled material that may occur while loading. The exterior of the trucks and railcars will be washed prior to leaving the loading area. All loads will be inspected to ensure no dredge materials are on the outside of the truck/railcar, and that the boxes are sealed and not leaking. Any spilled dredge material and water generated from cleaning the exterior of the truck/railcar will be captured and either shipped off-site with transloaded material or disposed of properly off-site, as described in the SWPPP (see below).
j. Loading practices (e.g., partially loading to provide freeboard; loading near the centerline of a car) will be employed to maximize liner effectiveness and prevent spillage.
k. A wheel wash must be installed if sediment is getting on the deck (dock) where trucks or other vehicles are passing through.
l. Wheel wash water cannot be allowed to enter surface waters or storm drains. Wheel wash wastewater must be collected and hauled off for proper disposal or routed to the

treatment area for discharge with stormwater under the NPDES permit as described in this section.

m. "Trucks entering and leaving" signs will be installed on both sides of the road accessing the facility to establish notice to the public.

n. Dust suppression will be handled with water misting of the sediment. A widespread water misting system will be strategically placed to moisten the exposed sediments and completely eliminate airborne particulates. In addition, dust will be fully suppressed at the surge/transload box by water misting. All water used for dust suppression will be contained within the barge.

o. The truck/railcar loading procedure will be as follows:
    i. Truck/railcar beds will be lined at the bed lining station.
    ii. Trucks/railcars will pull into the loading zone.
    iii. Sediments will be placed in the surge/transload box, if required, owing to sediment characteristics.
    iv. An excavator will supplement and mix drying agent with the sediments, as needed, to absorb any moisture prior to loading in the truck.
    v. Trucks/railcars will be loaded with special care to direct the material for transport to the landfill. On-board axle scales will facilitate loads to legal limits.
    vi. The loaded truck/railcar will be inspected for any latent spillage of sediment and immediately cleaned off.
    vii. The loaded truck/railcar will then move to the tarping station for load coverage prior to disembarking to the landfill.
    viii. Concurrently with the off-load of sediment, submersible pumps will be available to pump off any free liquids generated in the process either in the transport barges or surge box. Water generated will be allowed to settle and the water will be pumped off to a water hauler for disposal at an approved municipal treatment site or the landfill. Alternatively, water treatment may occur at a transload facility under an EPA-approved water quality management plan prepared by the party responsible for operation of a transload facility. Any discharge of treated water would occur in compliance with a transload facility's NPDES Industrial Stormwater General Permit. During pumping operations, all connections will be visually monitored for signs of leakage.
    ix. Housekeeping is imperative, and personnel will be dedicated to maintain drip pans, haul routes, and truck decontamination through the entire cycle of operations.

p. As a precaution, two large containment tanks will be permanently stationed at a facility to facilitate free liquids (if any) pumped off the sediment transport barges. During pumping operations, all connections will be visually monitored for signs of leakage.

q. Stormwater management at each transload facility will include the following:
    i. A facility will have an NPDES Industrial Stormwater General Permit, which will regulate all discharges to surface waters. All discharge from a facility will be regulated and in accordance with state water quality standards.

ii. A facility will have a SWPPP that describes operational and structural source control BMPs related to barge material transloading per CWA 401 and 402. The SWPPP will meet stormwater standards consistent with the SLOPES for stormwater, transportation, or utilities (NMFS 2014a), be approved by the EPA and verified by NMFS, and be available for review by all involved or interested agencies. The SWPPP must include all of the information called for by the current Checklist for Submission of a Stormwater Plan (DEQ 2008).

iii. The SWPPP will describe the routing and ultimate disposal of any water from the dredged material, all stormwater collected within the dredge material handling area, any water that is used for the wash-down of trucks/railcars and equipment, and any water that may come in contact with the dredged material or dredged material handling equipment. Only hardened (paved/concrete) drainage structures will be used to contain stormwater (i.e., not earthen berms). No stormwater associated with transloading will be discharged into a facility's stormwater treatment system or discharged back into the river unless it is covered under an NPDES permit and the SWPPP includes measures that ensure removal of the contaminants that are sufficiently stringent to meet both acute and chronic water quality criteria. If water is being treated at a facility for eventual discharge into the river, a water quality management plan developed by a transload facility operator must be submitted for approval to EPA prior to use of ta facility and will include both water quality (turbidity, pH, DO) and chemical (based on materials being handled at a facility) monitoring.

iv. The SWPPP will discuss the design storm criteria, including the "zero discharge" storm event. The SWPPP will also discuss the contingency for overflows above the design storm and controls to minimize stormwater adding to the water coming off the dredged sediments and the surrounding transload site.

9. Monitoring PDCs

Water Quality Monitoring

a. Water quality (WQ) monitoring will typically include visual monitoring for oil/sheen and distressed or dead fish, monitoring of conventional field parameters including turbidity, dissolved oxygen, and pH, monitoring of flow direction and water velocity, along with SMA/project-specific contaminants of concern (COCs). WQ monitoring requirements will be established in aa WQMP prior to construction. The WQMP will outline which COCs will be monitored and compared to acute and chronic criteria, as appropriate. The WQMP will also outline how each type of monitoring will work including background data for all parameters to ensure nominal levels for each parameter are accounted for in measuring short-term impacts.

b. WQ monitoring for conventional field parameters and SMA/project-specific COCs to ensure that BMPs are effective at reducing turbidity and the off-site migration of dissolved and particulate COCs would be required for most if not all remedial activities, including: dredging; capping and placement of materials for enhanced natural recovery (ENR), in situ treatment, and residual management; backfilling;

excavation and capping of riverbanks; removal of debris, pilings, and other structures; sheet pile installation and removal; ex situ treatment and dredge material dewatering in upland areas and/or on barges (with subsequent discharge of treated water to the river); construction and operation of an on-site transload facility (if applicable); construction of on-site habitat measures and potential off-site compensatory mitigation projects; and maintenance activities associated with the remedial action

c. The spatial direction of this monitoring will switch during tidal flow reversals during the in-water work window.
d. Water quality monitoring will also be conducted during the operation of a transload facility (assumed to be constructed on-site, but off-site transload facilities may be needed).
e. If water quality exceedances are detected or contamination observed (e.g., turbidity plume in the vicinity of the construction activity, the required response will include work slowing/stoppage, determination of the cause, modification of BMPs and/or operating methods, and additional monitoring, in accordance with the WQMP.
f. If distressed or dead fish or oil sheens are observed in the vicinity of the construction activity and associated with the construction activity, the required response will include work stoppage, determination of the cause, modification of BMPs and/or operating methods, and additional monitoring, in accordance with the WQMP.NMFS will be consulted on distressed or dead fish. Fish would be handled appropriately to minimize injury, or to conduct analysis of cause death or injury. NRC should be contacted for oil sheens.
g. Water quality exceedances, observations of visual contamination, oil sheens, or distressed or dead fish associated with construction activities will be recorded in the daily log and reported within two hours verbally or by email to the EPA so that response decisions, including additional monitoring, can be coordinated. BMPs and construction operations must be assessed for effectiveness and to correct the problem through modification of BMPs and/or operations in consultation with the EPA. Work stoppages shall not end until approval has been given by the EPA.

Contaminants of Concern Monitoring

a. WQMP will outline which COCs will be monitored and how acute and chronic criteria will be applied. The requirements of COC monitoring, including compliance points and criteria, would be established in the WQMP prior to construction.
b. At the beginning of construction or the start of new activities, intensive COC monitoring will be conducted in accordance with the WQMP (i.e., days 2, 4 and 6)
c. The frequency of COC monitoring may be reduced or eliminated following a period of no exceedances and at the approval of the EPA.
d. All monitoring station locations will be determined using GPS accurate to within ±3.28 feet (1 meter). Sampling depths will be the same as those established for turbidity monitoring locations described below.
e. COC monitoring will also be required if there is a confirmed turbidity exceedance, as described in the WQMP.
f. Alternative approaches to COC monitoring may be considered, as appropriate. This may include the development and use of correlations between COC concentrations and water quality and optical characteristics of the surface water (measurements of

turbidity, specific conductivity, DO, fluorescent dissolved organic matter, total algae, etc.). Such correlations may be applied to estimate COC concentrations from near-continuous time series of water quality and optical parameters. The correlations would be supplemented with periodic collection of water samples for background conditions and verification that the correlations are accurately predicting COC concentrations at the project area.

g. Background COC concentrations may be established pre-construction. The up current distance for monitoring background conditions should target a relatively undisturbed and unimpacted area up current from the work area, considering tidal influence.

Turbidity Monitoring

a. The following turbidity monitoring steps will be followed during remedial activities that have the potential to disturb sediments:
    i. Monitor turbidity using an appropriately and regularly calibrated turbidimeter. Remote sensing equipment or other appropriate technology may be used to monitor conventional field parameters.
    ii. Samples should be collected at a background station 300 feet up current and a compliance station 300 feet down current of the construction activity or as approved by the EPA. If more turbidity is visible down current than up current, the activity must be modified to reduce turbidity.
    iii. All monitoring station locations will be determined using GPS accurate to within ±3.28 feet (1 meter). Sampling depths for turbidity will be at the approximate top, middle, and bottom of the water column if the water depth permits collecting samples from three intervals at least five feet from each other. Top and bottom samples will be taken one foot below the surface of the water and between one and three feet above the mudline, respectively.
    iv. Turbidity will be measured at the start of each operation or new activity at least once every two hours during active in-water work unless otherwise approved by the EPA. More frequent monitoring may be required to ensure that the in-water work area is not contributing visible sediment to water. The first compliance sample will be taken a minimum of one hour after the start of the activity.
    v. Compliance results must be compared to the background sample collected during that monitoring event. At the point of compliance, short-term turbidity exceedances are allowed as follows:
        (1) 0 to 4 NTU above background: no restrictions
        (2) 5 to 29 NTU above background: Inspect construction and select additional control(s) that focus on the cause of exceedance. Work may continue for up to 4 hours. If exceedance continues after new controls are implemented, notify the EPA and cease all in-water activities. Work may resume when turbidity is 0-5 NTUs above background or if approved by the EPA.
        (3) 30 to 49 NTU above background: Inspect construction and select additional control(s) that focuses on cause of exceedance. Work may continue for up to 2 hours. If exceedance continues after new controls are implemented, notify the EPA and cease all in-water activities. Work may

resume when turbidity is 0-5 NTUs above background or if approved by the EPA.

(4) 50 NTU or more above background: Notify the EPA. Cease all in-water activities until turbidity is 0-5 NTUs above background or measures have returned to compliant levels or approval has been given by the EPA.

(5) Turbidity levels shall not exceed 5 NTUs more than background turbidity when the background turbidity is 50 NTUs (monitored and reported to NMFS and the EPA) or less, or there shall not be more than a 10 percent increase in turbidity when the background turbidity is more than 50 NTUs

vi. Background turbidity may be established pre-construction. The up current distance for monitoring background conditions should target a relatively undisturbed and unimpacted area up current from the work area, considering tidal influence. As the Lower Willamette River is tidally influenced, if flow reversal is observed to occur during monitoring, then the sampling stations will be reversed to continue the down current and up current (for background conditions) pattern as appropriate. Measurements of current velocities and/or turbidity plumes will be required to confirm field observations and decisions on monitoring locations relative to tidal influence.

Monitoring Long-Term Sediment Loading to the Columbia River

a. Sediment dispersal and loading from the Site to the Columbia River will be measured empirically to ensure concentrations of COCs are trending downward over time, as required by the ROD (EPA 2017a).
b. Empirical monitoring could include measurements of bedload and water column concentrations of COCs exiting the Site at the downstream end. Monitoring is likely to be consistent with the methods used during the Pre-RD Group baseline sampling for conducting high-volume surface water sampling and the use of sediment traps.

10) Habitat Impact Minimization and Offsets/Restoration PDCs

Measures required to minimize and offset impacts to shallow water and riparian habitat, include the following:

a. Following dredging in shallow-water areas, backfill to restore the existing (pre-dredging) elevation to avoid loss of shallow-water habitat.
b. To offset permanent and/or temporal loss of habitat functions from dredging and capping in shallow water areas and as on-site mitigation, lay back or extend the slope out to as close to a 5H:1V slope as practicable given site-specific conditions. Where creation of shallow slopes is not practicable, the creation of adjacent off-channel habitat or enhancement of other habitat conditions important for juvenile salmonids may be used to offset the loss of shallow slopes.
c. In shallow areas, dredging prior to capping may be required to avoid loss of shallow-water habitat. Creation of new shallow-water habitat in remedial designs may be allowed where it does not conflict with floodway/floodrise executive order considerations. This will allow for additional compensatory mitigation options for other cleanup areas that are unable to fully self-mitigate within a project area.

d. Apply an engineered beach mix layer as described in PDC 11) Capping and Treatment PDCs.
e. To offset permanent and/or temporary loss of habitat functions from excavation and capping/covering on riverbanks and as on-site mitigation, following soil removal on riverbanks, lay back or extend out riverbank slopes to as close as a 5H:1V slope as practicable given site-specific conditions.
f. Incorporate vegetation into caps/covers placed on riverbanks where possible, such as in off-channel areas that are not prone to erosion and with shallow slopes (i.e., slopes less than 1.7H:1V).
g. Include large wood to the extent feasible:
    i. Place large wood in areas where it would naturally occur and in a manner that closely mimics natural accumulations on the Lower Willamette River.
    ii. Stabilizing or key pieces of large wood that will be relied on to provide streambank stability or redirect flows must be intact, hard, and undecayed to partly decaying, and should have untrimmed root wads to provide functional refugia habitat for fish.
    iii. Use of decayed or fragmented wood found lying on or partially sunken in the ground is prohibited.
    iv. Anchoring alternatives may be used in preferential order: (1) use adequately sized wood sufficient for stability, (2) orient and place wood in such a way that movement is limited, (3) use ballast (gravel and/or rock) to increase the mass of the structure to resist movement (4) use large boulders as anchor points for the large wood.
h. Purchase of conservation credits to offset the temporary or permanent loss of habitat or habitat function is an acceptable offset if the impact cannot be avoided or minimized, which must be demonstrated prior to proposing use of mitigation credits. Habitat impact calculators may be used to aid this effort. The outputs from these calculations would be verified by NMFS and the EPA prior to credit purchase or verification under this Opinion.
i. Use the best available scientific information regarding the likely effects of climate change on resources in the project area, including projections of local stream flow and water temperature, to ensure that the project will be adaptable to those changes.

Revegetation

a. Plant and seed disturbed areas before or at the beginning of the first growing season after construction.
b. Use species that will achieve shade and erosion control objectives, including forb, grass, shrub, or tree species that are appropriate for the site and native to the project area or region.
c. Short-term stabilization measures may include the use of non-native sterile seed mix if native seeds are not available, weed-free certified straw, jute matting, and similar methods.
d. When feasible, use vegetation salvaged from local areas scheduled for clearing
    a. due to development.
e. Do not apply surface fertilizer within 50 feet of any wetland of water body.
f. Install fencing as necessary to prevent access to revegetated sites by

a. unauthorized persons.

g. Do not use invasive or non-native species for site restoration.
h. Remove or control invasive plants until native plant species are well-established.

Invasive and non-native plant control

a. Non-herbicide methods. Limit vegetation removal and soil disturbance within the riparian zone by limiting the number of workers there to the minimum necessary to complete manual and mechanical plant control (e.g., hand pulling, clipping, stabbing, digging, brush-cutting, mulching or heating with radiant heat, pressurized hot water, or heated foam).
b. Herbicide label. Herbicide applicators must comply with all label instructions.
c. Power equipment. Refuel gas-powered equipment with tanks larger than 5 gallons in a vehicle staging area placed 150 feet or more from any natural waterbody, or in an isolated hazard zone such as a paved parking lot.
d. Maximum herbicide treatment area. For the total area treated with herbicides within riparian areas, do not exceed 10 acres above bankfull elevation and 2 acres below bankfull elevation per 1.6-mile reach of a stream per year.
e. Herbicide applicator qualifications. Herbicides may only be applied by an appropriately licensed applicator using an herbicide specifically targeted for a particular plant species that will cause the least impact. The applicator will be responsible for preparing and carrying out the herbicide transportation and safely plan, as follows.
f. Herbicide transportation and safety plan. The applicator will prepare and carry out an herbicide safety/spill response plan to reduce the likelihood of spills or misapplication, to take remedial actions in the event of spills, and to fully report the event.
g. Herbicides. The only herbicides proposed for use under this Opinion are (some common trade names are shown in parentheses):
    i. Aquatic imazapyr (e.g., Habitat)
    ii. aquatic glyphosate (e.g., AquaMaster, AquaPro, Rodeo)
    iii. aquatic triclopyr-TEA (e.g., Renovate 3)
    iv. chlorsulfuron (e.g., Telar, Glean, Corsair)
    v. clopyralid (e.g., Transline)
    vi. imazapic (e.g., Plateau)
    vii. imazapyr (e.g., Arsenal, Chopper)
    viii. metsulfuron-methyl (e.g., Escort)
    ix. picloram (e.g., Tordon)
    x. sethoxydim (e.g., Poast, Vantage)
    xi. sulfometuron-methyl (e.g., Oust, Oust XP)
h. Herbicide adjuvants. The only adjuvants proposed for use under this Opinion are as follows, with mixing rates described in label instructions (Table 3). Polyethoxylated tallow amine (POEA) surfactant and herbicides that containPOEA (e.g., Roundup) will not be used.
i. Herbicide carriers. Herbicide carriers (solvents) are limited to water or specifically labeled vegetable oil. Use of diesel oil as an herbicide carrier is prohibited.

j. Herbicide mixing. Mix herbicides more than 150 feet from any natural waterbody to minimize the risk of an accidental discharge.
k. Dyes. Use a non-hazardous indicator dye (e.g., Hi-Light or Dynamark™) with herbicides within 100 feet of live water. The presence of dye makes it easier to see where the herbicide has been applied and where or whether it has dripped, spilled, or leaked. Dye also makes it easier to detect missed spots, avoid spraying a plant or area more than once, and minimize over-spraying (SERA 1997).
l. Spill cleanup kit. Provide a spill cleanup kit whenever herbicides are used transported, or stored. At a minimum, cleanup kits will include Material Safety Data Sheets, the herbicide label, emergency phone numbers, and absorbent material such as cat litter to contain spills.
m. Herbicide application rates. Apply herbicides at the lowest effective label rates.
n. Herbicide application methods. Apply liquid or granular forms of herbicides as follows:
    i. Broadcast spraying – hand-held nozzles attached to backpack tanks or vehicles, or by using vehicle-mounted booms.
    ii. Spot spraying – hand-held nozzles attached to backpack tanks or vehicles, hand-pumped spray, or squirt bottles to spray herbicide directly onto small patches or individual plants using.
    iii. Hand/selective – wicking and wiping, basal bark, fill ("hack and squirt"), stem injection, cut-stump.
    iv. Triclopyr – will not be applied by broadcast spraying.
    v. Keep the spray nozzle within 4 feet of the ground; 6 feet for spot or patch spraying more than 15 feet of the high-water mark (HWM) if needed to treat tall vegetation
    vi. Apply spray in swaths parallel to the project area, away from the creek and desirable vegetation, i.e., the person applying the spray will generally have their back to the creek or other sensitive resource.
    vii. Avoid unnecessary runoff during cut surface, basal bark, and hacksquirt/ injection applications.
o. Washing spray tanks. Wash spray tanks 300 feet or more away from any surface water.
p. Minimization of herbicide drift and leaching. Minimize herbicide drift and leaching will as follows:
    i. Do not spray when wind speeds exceed 10 miles per hour, or are less than 2 miles per hour.
    ii. Be aware of wind directions and the potential for herbicides to affect aquatic habitat area downwind.
    iii. Keep boom or spray as low as possible to reduce wind effects.
    iv. Increase spray droplet size whenever possible by decreasing spray pressure, using high flow rate nozzles, using water diluents instead of oil, and adding thickening agents.
    v. Do not apply herbicides during temperature inversions, or when ground temperatures exceed 80 degrees Fahrenheit.
    vi. Wind and other weather data will be monitored and reported for all broadcast applications.

q. Rain. Do not apply herbicides when the soil is saturated or when a precipitation event likely to produce direct runoff to salmon-bearing waters from the treated area is forecasted by the NOAA National Weather Service or other similar forecasting service within 48 hours following application. Soil-activated herbicides may follow label instructions. Do not conduct hack-squirt/injection applications during periods of heavy rainfall.

r. Herbicide buffer distances. Observe the following no-application buffers, measured in feet and are based on herbicide formula, stream type, and application method, during herbicide applications (Table 1). Use the most conservative buffer for any herbicide included in a combination of approved herbicides. Buffer widths are in feet, measured as map distance perpendicular to the bankfull elevation for streams, the upland boundary for wetlands, or the upper bank for roadside ditches. Before herbicide application begins, flag or mark the upland boundary of each applicable herbicide buffer to ensure that all buffers are in place and functional during treatment.

Table 1. Herbicide buffer distances by herbicide formula, stream type, and application method.

Herbicide	**No Application Buffer Width (feet)**					
	Streams and Roadside Ditches with flowing or standing water present and Wetlands			Dry Streams, Roadside Ditches, and Wetlands		
	Broadcast Spraying	Spot Spraying	Hand Selective	Broadcast Spraying	Spot Spraying	Hand Selective
Labeled for Aquatic Use						
Aquatic Glyphosate	100	waterline	waterline	50	None	none
Aquatic Imazapyr	100	15	waterline	50	None	none
Aquatic Triclopyr-TEA	**Not Allowed**	15	waterline	**Not Allowed**	None	none
Low Risk to Aquatic Organisms						
Imazapic	100	15	bankfull elevation	50	None	none
Clopyralid	100	15	bankfull elevation	50	None	none
Metsulfuron-methyl	100	15	bankfull elevation	50	None	none
Moderate Risk to Aquatic Organisms						
Imazapyr	100	50	bankfull elevation	50	15	bankfull elevation
Sulfometuron-methyl	100	50	5	50	15	bankfull elevation
Chlorsulfuron	100	50	bankfull elevation	50	15	bankfull elevation
High Risk to Aquatic Organisms						
Picloram	100	50	50	100	50	50
Sethoxydim	100	50	50	100	50	50

Boulder Placement

a. Boulder placement is limited to riparian area restoration actions and should be located in areas that consist predominantly of coarse gravel or larger sediments.
b. Install boulders as follows:
    i. The cross-sectional area of boulders may not exceed 25% of the cross-sectional area of the low flow channel, or be installed to shift the stream flow to a single flow pattern in the middle or to the side of the stream.
    ii. Boulders will be machine-placed (no end dumping allowed)
    iii. Permanent anchoring, including rebar and cables, may not be used.

Set back existing berm, dike, or levee

a. To the greatest degree possible, non-native fill material originating from outside the floodplain of the action area will be removed from the floodplain to an upland site.
b. Where it is not possible to remove or set back all portions of dikes and berms, or in areas where existing berms, dikes, and levees support abundant riparian vegetation, openings will be created with breaches.
    i. Breaches shall be equal to or greater than the active channel width.
    ii. In addition to other breaches, the berm, dike, or levee shall always be breached at the downstream end of the project and/or at the lowest elevation of the floodplain to ensure the flows will naturally recede back into the main channel, thus minimizing fish entrapment.
    iii. When necessary, loosen compacted soils once overburden material is removed.

c. Overburden or fill comprised of native materials, which originated from the project area, may be used within the floodplain to create set-back dikes and fill anthropogenic holes provided that does not impede floodplain function.

Riprap

a. The primary habitat functions of concern are related to floodplain connectivity, forage, natural cover, and free passage. Acceptable mitigation for those losses include:
    i. removal of existing riprap;
    ii. retrofit existing riprap with vegetated riprap and LW or one or more other streambank stabilization methods described in this Opinion;
    iii. restoration of shallow water or off-channel habitats;
    iv. conservation bank credit purchase

Unavoidable Impact Offsets

a. A compensatory mitigation plan (Appendix D) must accompany any project review request for any activity that would otherwise result in loss of habitat function that cannot be avoided or minimized.
b. The compensatory mitigation plan must describe:
    i. How the responsible party will offset the unavoidable adverse impacts, including sketches, drawings, specifications, calculations, or other information commensurate with the scope of the action.

ii. What practices will be used to ensure offset or compensation for the impacts by providing equivalent substitute resources of environments.
iii. Completion before, or concurrent with, construction whenever possible.
iv. How the responsible party will achieve a mitigation ratio that is greater than one-to-one and larger when necessary to compensate for time lags between the loss of conservation value in the project area and replacement of conservation value in the mitigation area, uncertainty of conservation value replacement in the mitigation area, or when the affected area has demonstrably higher conservation value than the mitigation area (e.g., 1.5 to 1.0 ratio).
v. When practicable and environmentally sound, actions to offset impacts to ESA species/critical habitat should be near the project impact site, or within the same local watershed and area occupied by the affected population(s) and age classes. Compensation should be completed prior to or concurrent with the adverse impacts, or have an increased ratio as noted above.
vi. The name, address, and telephone number of a person responsible for designing this part of the action that NMFS may contact if additional information is necessary to complete the effects analysis.

c. To minimize delays and objections during the review process, responsible parties are encouraged to seek the advice of NMFS during the planning and design of mitigation plans. For complex mitigation projects, such consultation may improve the likelihood of mitigation success and reduce processing time.

11) Stormwater Management

a. Projects triggering stormwater management shall be designed consistent with stormwater management PDCs included in the SLOPES Stormwater and Transportation Programmatic Opinion (NMFS 2014), or most recent version thereof, and will require NMFS' approval of a stormwater management plan.
b. Any stormwater management facility that requires a new or enlarged structure within the riparian zone, e.g., transloading facility, or that has insufficient capacity to infiltrate and retain the volume of stormwater called for by this Opinion, requires compensatory mitigation as follows:
    i. The primary habitat functions of concern are related to the physical and biological features essential to the long-term conservation of listed species, i.e., water quality, water quantity, channel substrate, floodplain connectivity, forage, natural cover (such as submerged and overhanging LW, aquatic vegetation, large rocks and boulders, side channels and undercut banks), space, and free passage.
    ii. Acceptable mitigation for riparian habitat displaced by a stormwater treatment facility is restoration of shallow-water or off-channel habitat and/or purchase of conservation credits.
    iii. Acceptable mitigation for inadequate stormwater treatment includes providing adequate stormwater treatment where it did not exist before, and retrofitting an existing but substandard stormwater facility to provide capacity necessary to infiltrate and retain the proper volume of stormwater. Such mitigation can be measured in terms of deficit stormwater treatment capacity.

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

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

2.1. Analytical Approach

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

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

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

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

2.2. Rangewide Status of the Species and Critical Habitat

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

One factor affecting the status of ESA-listed species considered in this Opinion, and aquatic habitat at large, is climate change. Climate change is likely to play an increasingly important role in determining the abundance and distribution of ESA-listed species, and the conservation value of designated critical habitats, in the Pacific Northwest. These changes will not be spatially homogeneous across the Pacific Northwest. Major ecological realignments are already occurring in response to climate change (IPCC WGII, 2022). Long-term trends in warming have continued at global, national, and regional scales. Global surface temperatures in the last decade (2010s) were estimated to be 1.09 °C higher than the 1850-1900 baseline period, with larger increases over land ~1.6 °C compared to oceans ~0.88 (IPCC WGI, 2021). The vast majority of this warming has been attributed to anthropogenic releases of greenhouse gases (IPCC WGI, 2021). Globally, 2014-2018 were the five warmest years on record both on land and in the ocean (2018 was the fourth warmest) (NOAA NCEI 2022). Events such as the 2013-2016 marine heatwave (Jacox et al. 2018) have been attributed directly to anthropogenic warming in the annual special issue of Bulletin of the American Meteorological Society on extreme events (Herring et al. 2018). Global warming and anthropogenic loss of biodiversity represent profound threats to ecosystem functionality (IPCC WGII 2022). These two factors are often examined in isolation, but likely have interacting effects on ecosystem function.

Updated projections of climate change are similar to or greater than previous projections (IPCC WGI, 2021). NMFS is increasingly confident in our projections of changes to freshwater and marine systems because every year brings stronger validation of previous predictions in both physical and biological realms. Retaining and restoring habitat complexity, access to climate refuges (both flow and temperature) and improving growth opportunity in both freshwater and marine environments are strongly advocated in the recent literature (Siegel and Crozier 2020).

Climate change is systemic, influencing freshwater, estuarine, and marine conditions. Other systems are also being influenced by changing climatic conditions. Literature reviews on the impacts of climate change on Pacific salmon (Crozier 2015, 2016, 2017, Crozier and Siegel 2018, Siegel and Crozier 2019, 2020) have collected hundreds of papers documenting the major themes relevant for salmon. Here we describe habitat changes relevant to Pacific salmon and steelhead, prior to describing how these changes result in the varied specific mechanisms impacting these species in subsequent sections.

Climate change will impact the forests of the western U.S., which dominate the landscape of many watersheds in the region. Forests are already showing evidence of increased drought severity, forest fire, and insect outbreak (Halofsky et al. 2020). Additionally, climate change will affect tree reproduction, growth, and phenology, which will lead to spatial shifts in vegetation. Halofsky et al. (2018) projected that the largest changes will occur at low- and high-elevation forests, with expansion of low-elevation dry forests and diminishing high-elevation cold forests and subalpine habitats.

Forest fires affect salmon streams by altering sediment load, channel structure, and stream temperature through the removal of canopy. Holden et al. (2018) examined environmental factors contributing to observed increases in the extent of forest fires throughout the western U.S. They found strong correlations between the number of dry-season rainy days and the annual extent of forest fires, as well as a significant decline in the number of dry-season rainy days over the study period (1984-2015). Consequently, predicted decreases in dry-season precipitation, combined with increases in air temperature, will likely contribute to the existing trend toward more extensive and severe forest fires and the continued expansion of fires into higher elevation and wetter forests (Alizedeh 2021).

Agne et al. (2018) reviewed literature on insect outbreaks and other pathogens affecting coastal Douglas-fir forests in the Pacific Northwest and examined how future climate change may influence disturbance ecology. They suggest that Douglas-fir beetle and black stain root disease could become more prevalent with climate change, while other pathogens will be more affected by management practices. Agne et al. (2018) also suggested that due to complex interacting effects of disturbance and disease, climate impacts will differ by region and forest type.

Cooper et al. (2018) examined whether the magnitude of low river flows in the western U.S., which generally occur in September or October, are driven more by summer conditions or the prior winter's precipitation. They found that while low flows were more sensitive to summer evaporative demand than to winter precipitation, interannual variability in winter precipitation was greater. Malek et al. (2018) predicted that summer evapotranspiration is likely to increase in conjunction with declines in snowpack and increased variability in winter precipitation. Their results suggest that low summer flows are likely to become lower, more variable, and less predictable.

The effect of climate change on groundwater availability is likely to be uneven. Sridhar et al. (2018) coupled a surface-flow model with a ground-flow model to improve predictions of surface water availability with climate change in the Snake River Basin. Projections using RCP 4.5 and 8.5 emission scenarios suggested an increase in water table heights in downstream areas of the basin and a decrease in upstream areas.

As cited in Siegel and Crozier (2019), Isaak et al. (2018) examined recent trends in stream temperature across the Western U.S. using a large regional dataset. Stream warming trends paralleled changes in air temperature and were pervasive during the low-water warm seasons of 1996-2015 (0.18-0.35°C/decade) and 1976-2015 (0.14-0.27°C/decade). Their results show how continued warming will likely affect the cumulative temperature exposure of migrating sockeye salmon (*O. nerka*) and the availability of suitable habitat for brown trout (*Salmo trutta*) and rainbow trout (*O. mykiss*). Isaak et al. (2018) concluded that most stream habitats will likely remain suitable for salmonids in the near future, with some becoming too warm. However, in cases where habitat access is currently restricted by dams and other barriers salmon and steelhead will be confined to downstream reaches, typically most at risk of rising temperatures unless passage is restored (FitzGerald et al. 2020, Myers et al. 2018).

Streams with intact riparian corridors in mountainous terrain are likely to be more resilient to changes in air temperature. These areas may provide refuge from climate change for a number of species, including Pacific salmon. Krosby et al. (2018) identified potential stream refugia throughout the Pacific Northwest based on a suite of features thought to reflect the ability of streams to serve as such refuges. Analyzed features include large temperature gradients, high canopy cover, large relative stream width, low exposure to solar radiation, and low levels of human modification. They created an index of refuge potential for all streams in the region, with mountain area streams scoring highest. Flat lowland areas, which commonly contain migration corridors, were generally scored lowest, and thus were prioritized for conservation and restoration. However, forest fires can increase stream temperatures dramatically in short time spans by removing riparian cover (Koontz et al. 2018), and streams that lose their snowpack with climate change may see the largest increases in stream temperature due to the removal of temperature buffering (Yan et al. 2021). These processes may threaten some habitats that are currently considered refugia.

In marine and estuarine environments, a recent study projects a nearly complete loss of existing tidal wetlands along the U.S. West Coast due to sea level rise (Thorne et al. 2018). California and Oregon showed the greatest threat to tidal wetlands (100 percent), while 68 percent of Washington tidal wetlands are expected to be submerged. Coastal development and steep topography prevent horizontal migration of most wetlands, causing the net contraction of this crucial habitat.

Rising ocean temperatures, stratification, ocean acidity, hypoxia, algal toxins, and other oceanographic processes will alter the composition and abundance of a vast array of oceanic species. In particular, there will be dramatic changes in both predators and prey of Pacific salmon, salmon life history traits, and relative abundance. Siegel and Crozier (2019) observe that changes in marine temperature are likely to have a number of physiological consequences on fishes themselves. For example, in a study of small planktivorous fish, Gliwicz et al. (2018) found that higher ambient temperatures increased the distance at which fish reacted to prey. Numerous fish species (including many tuna and sharks) demonstrate regional endothermy, which in many cases augments eyesight by warming the retinas. However, Gliwicz et al. (2018) suggest that ambient temperatures can similarly affect fish that do not demonstrate this trait. Climate change is likely to reduce the availability of biologically essential omega-3 fatty acids produced by phytoplankton in marine ecosystems. Loss of these lipids may induce cascading trophic effects, with distinct impacts on different species depending on compensatory mechanisms (Gourtay et al. 2018). Reproduction rates of many marine fish species are also likely to be altered with temperature (Veilleux et al. 2018). The ecological consequences of these effects and their interactions add complexity to predictions of climate change impacts in marine ecosystems.

Perhaps the most dramatic change in physical ocean conditions will occur through ocean acidification and deoxygenation. It is unclear how sensitive salmon and steelhead might be to the direct effects of ocean acidification because of their tolerance of a wide pH range in freshwater (although see Ou et al. 2015 and Williams et al. 2019); however, impacts of ocean acidification and hypoxia on sensitive species (e.g., plankton, crabs, rockfish, groundfish) will likely affect salmon indirectly through their interactions as predators and prey. Similarly, increasing frequency and duration of harmful algal blooms may affect salmon directly, depending on the toxin (e.g., saxitoxin vs domoic acid), but will also affect their predators (seabirds and mammals). The full effects of these ecosystem dynamics are not known but will be complex. Within the historical range of climate variability, less suitable conditions for salmonids (e.g., warmer temperatures, lower streamflows) have been associated with detectable declines in many of these listed units, highlighting how sensitive they are to climate drivers (Ford 2022, Lindley et al. 2009, Williams et al. 2016, Ward et al. 2015). In some cases, the combined and potentially additive effects of poorer climate conditions for fish and intense anthropogenic impacts caused the population declines that led to these population groups being listed under the ESA (Crozier et al. 2019).

In freshwater, climate change will affect salmon and steelhead and the functions that make and maintain their habitat. Year-round increases in stream temperature and changes in flow will affect physiological, behavioral, and demographic processes in salmon, and change the species with which they interact. For example, as stream temperatures increase, many native salmonids face increased competition with more warm-water tolerant invasive species. Changing freshwater temperatures are likely to affect incubation and emergence timing for eggs, and in locations where the greatest warming occurs may affect egg survival, although several factors impact intergravel temperature and oxygen (e.g., groundwater influence) as well as sensitivity of eggs to thermal stress (Crozier et al. 2020). Changes in temperature and flow regimes may alter the amount of habitat and food available for juvenile rearing, which could lead to a restriction in the distribution of juveniles, further decreasing productivity through density dependence. For migrating adults, predicted changes in freshwater flows and temperatures will likely increase exposure to stressful temperatures for many salmon and steelhead populations, alter migration travel times, and increase thermal stress accumulation for ESUs or DPSs with early-returning (i.e., spring- and summer-run) phenotypes associated with longer freshwater holding times (Crozier et al. 2020, FitzGerald et al. 2020). Rising river temperatures increase the energetic cost of migration and the risk of *en route* or pre-spawning mortality of adults with long freshwater migrations. However, populations of some ESA-listed salmon and steelhead may be able to use cool-water refuges and run-timing plasticity to reduce thermal exposure (Keefer et al. 2018, Barnett et al. 2020).

Marine survival of salmonids is affected by a complex array of factors, including prey abundance, predator interactions, the physical condition of salmon within the marine environment, and carryover effects from the freshwater experience (Holsman et al. 2012, Burke et al. 2013). It is generally accepted that salmon marine survival is size-dependent, and thus larger and faster-growing fish are more likely to survive (Gosselin et al. 2021). Furthermore, early arrival timing in the marine environment is generally considered advantageous for populations migrating through the Columbia River. However, the optimal day of arrival varies across years, depending on the seasonal development of productivity in the California Current, which affects prey available to salmon and the risk of predation (Chasco et al. 2021). Siegel and Crozier (2019) point out the concern that for some salmon populations, climate change may drive mismatches between juvenile arrival timing and prey availability in the marine environment. However, phenological diversity can contribute to metapopulation-level resilience by reducing the risk of a complete mismatch. Carr-Harris et al. (2018) explored phenological diversity of marine migration timing in relation to zooplankton prey for sockeye salmon (*O. nerka*) from the Skeena River of Canada. They found that sockeye migrated over more than 50 days, and populations from higher elevation and further inland streams arrived in the estuary later, with different populations encountering distinct prey fields. Carr-Harris et al. (2018) recommended that managers maintain and augment such life-history diversity.

Synchrony between terrestrial and marine environmental conditions (e.g., coastal upwelling, precipitation and river discharge) has increased in spatial scale, causing the highest levels of synchrony in the last 250 years (Black et al. 2018). A more synchronized climate combined with simplified habitats and reduced genetic diversity may be leading to more synchrony in the productivity of populations across the range of salmon (Braun et al. 2016). For example, salmon productivity (recruits/spawner) has also become more synchronized across Chinook populations from Oregon to the Yukon (Dorner et al. 2018, Kilduff et al. 2014). In addition, Chinook salmon have become smaller and younger at maturation across their range (Ohlberger 2018). Other Pacific salmon species (Stachura et al. 2014) and Atlantic salmon (Olmos et al. 2020) also have demonstrated synchrony in productivity across a broad latitudinal range.

At the individual scale, climate impacts on salmon in one life stage generally affect body size or timing in the next life stage, and negative impacts can accumulate across multiple life stages (Healey 2011, Wainwright and Weitkamp 2013, Gosselin et al. 2021). Changes in winter precipitation will likely affect incubation and/or rearing stages of most populations. Changes in the intensity of cool-season precipitation, snow accumulation, and runoff could influence migration cues for fall, winter and spring adult migrants, such as coho and steelhead. Egg survival rates may suffer from more intense flooding that scours or buries redds. Changes in hydrological regime, such as a shift from mostly snow to more rain, could drive changes in life history, potentially threatening diversity within an ESU (Beechie et al. 2006). Changes in summer temperature and flow will affect both juvenile and adult stages in some populations, especially those with yearling life histories and summer migration patterns (Crozier and Zabel 2006, Crozier et al. 2010, Crozier et al. 2019).

At the population level, the ability of organisms to genetically adapt to climate change depends on how much genetic variation currently exists within salmon populations, as well as how selection on multiple traits interact, and whether those traits are linked genetically. While genetic diversity may help populations respond to climate change, the remaining genetic diversity of many populations is highly reduced compared to historic levels. For example, Johnson et al. (2018) compared genetic variation in Chinook salmon from the Columbia River Basin between contemporary and ancient samples. A total of 84 samples determined to be Chinook salmon were collected from vertebrae found in ancient middens and compared to 379 contemporary samples. Results suggest a decline in genetic diversity, as demonstrated by a loss of mitochondrial haplotypes and reductions in haplotype and nucleotide diversity. Genetic losses in this comparison appeared larger for Chinook from the mid-Columbia than those from the Snake River basin. In addition to other stressors, modified habitats and flow regimes may create unnatural selection pressures that reduce the diversity of functional behaviors (Sturrock et al. 2020). Managing to conserve and augment existing genetic diversity may be increasingly important with more extreme environmental change (Anderson et al. 2015), though the low levels of remaining diversity present challenges to this effort (Freshwater 2019). Salmon historically maintained relatively consistent returns across variation in annual weather through the portfolio effect (Schindler et al. 2015), in which different populations are sensitive to different climate drivers. Applying this concept to climate change, Anderson et al. (2015) emphasized the additional need for populations with different physiological tolerances. Loss of the portfolio increases volatility in fisheries, as well as ecological systems, as demonstrated for Fraser River and Sacramento River stock complexes (Freshwater et al. 2019, Munsch et al. 2022).

2.2.1 Status of the Species

For Pacific salmon, steelhead, and certain other species, we commonly use the four "viable salmonid population" (VSP) criteria (McElhany et al. 2000) to assess the viability of the populations that, together, constitute the species. These four criteria (spatial structure, diversity, abundance, and productivity) encompass the species' "reproduction, numbers, or distribution" as described in 50 CFR 402.02. When these parameters are collectively at appropriate levels, they maintain a population's capacity to adapt to various environmental conditions and allow it to sustain itself in the natural environment. The most recent *"Viability Assessment Update for Pacific Salmon and Steelhead Listed under the ESA: Pacific Northwest"* was finalized in January 2022 (Ford 2022) and provides the basis for the most recent status information for salmonid species covered by this Opinion.

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

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

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

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

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

The summaries that follow describe the status of ESA-listed species and their designated critical habitats that occur within the geographic area of this proposed action and are considered in this opinion. More detailed information on the status and trends of these listed resources, and their biology and ecology, are in the listing regulations and critical habitat designations published in the Federal Register, and *“Viability Assessment Update for Pacific Salmon and Steelhead Listed under the ESA: Pacific Northwest”* (Ford 2022) and these are incorporated by reference.

Table 2 below provides a summary of listing and recovery plan information, status summaries and limiting factors for the species addressed in this Opinion. More information can be found in the recovery plans and status reviews for these species. Acronyms appearing in the table include DPS (Distinct Population Segment), ESU (Evolutionarily Significant Unit), ICTRT (Interior Columbia Technical Recovery Team), MPG (Multiple Population Grouping), NWFSC (Northwest Fisheries Science Center), TRT (Technical Recovery Team), and VSP (Viable Salmonid Population).

Table 2 Listing classification and date, recovery plan reference, most recent status review, status summary, and limiting factors for each species considered in this opinion.

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
Lower Columbia River Chinook salmon	Threatened 6/28/05	NMFS 2013	NMFS 2022a; Ford 2022	This ESU comprises 32 independent populations. Relative to baseline VSP levels identified in the recovery plan (Dornbusch 2013), there has been an overall improvement in the status of a number of fall-run populations although most are still far from the recovery plan goals; Spring-run Chinook salmon populations in this ESU are generally unchanged; most of the populations are at a "high" or "very high" risk due to low abundances and the high proportion of hatchery-origin fish spawning naturally. Many of the populations in this ESU remain at "high risk," with low natural-origin abundance levels. Overall, we conclude that the viability of the Lower Columbia River Chinook salmon ESU has increased somewhat since 2016, although the ESU remains at "moderate" risk of extinction	• Reduced access to spawning and rearing habitat • Hatchery-related effects • Harvest-related effects on fall Chinook salmon • An altered flow regime and Columbia River plume • Reduced access to off-channel rearing habitat • Reduced productivity resulting from sediment and nutrient-related changes in the estuary • Contaminant
Upper Columbia River spring-run Chinook salmon	Endangered 6/28/05	Upper Columbia Salmon Recovery Board 2007	NMFS 2022b; Ford 2022	This ESU comprises four independent populations. Current estimates of natural-origin spawner abundance decreased substantially relative to the levels observed in the prior review for all three extant populations. Productivities also continued to be very low, and both abundance and productivity remained well below the viable thresholds called for in the Upper Columbia Salmon Recovery Plan for all three populations. Based on the information available for this review, the Upper Columbia River spring-run Chinook salmon ESU remains at high risk, with viability largely unchanged since 2016.	• Effects related to hydropower system in the mainstem Columbia River • Degraded freshwater habitat • Degraded estuarine and nearshore marine habitat • Hatchery-related effects • Persistence of non-native (exotic) fish species • Harvest in Columbia River fisheries

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
Snake River spring/summer-run Chinook salmon	Threatened 6/28/05	NMFS 2017a	NMFS 2022c; Ford 2022	This ESU comprises 28 extant and four extirpated populations. There have been improvements in abundance/productivity in several populations relative to the time of listing, but the majority of populations experienced sharp declines in abundance in the recent five-year period Overall, at this time we conclude that the Snake River spring/ summer-run Chinook salmon ESU continues to be at moderate-to-high risk.	• Degraded freshwater habitat • Effects related to the hydropower system in the mainstem Columbia River, • Altered flows and degraded water quality • Harvest-related effects • Predation
Upper Willamette River Chinook salmon	Threatened 6/28/05	NMFS 2011	NMFS 2024; Ford 2022	This ESU comprises seven populations. Abundance levels for all but Clackamas River DIP remain well below their recovery goals. Overall, there has likely been a declining trend in the viability of the Upper Willamette River Chinook salmon ESU since the last review. The magnitude of this change is not sufficient to suggest a change in risk category, however, so the Upper Willamette River Chinook salmon ESU remains at "moderate" risk of extinction.	• Degraded freshwater habitat • Degraded water quality • Increased disease incidence • Altered stream flows • Reduced access to spawning and rearing habitats • Altered food web due to reduced inputs of microdetritus • Predation by native and non-native species, including hatchery fish • Competition related to introduced salmon and steelhead • Altered population traits due to fisheries and bycatch
Snake River fall-run Chinook salmon	Threatened 6/28/05	NMFS 2017b	NMFS 2022e; Ford 2022	This ESU has one extant population The single extant population in the ESU is currently meeting the criteria for a rating of "viable" developed by the ICTRT, but the ESU as a whole is not meeting the recovery goals described in the recovery plan for the species, which require the single population to be "highly viable with high certainty" and/or will require reintroduction of a viable population above the Hells Canyon Complex (NMFS 2017b). The Snake River fall-run Chinook salmon ESU therefore is considered to be at a moderate-to- low risk of extinction.	• Degraded floodplain connectivity and function • Harvest-related effects • Loss of access to historical habitat above Hells Canyon and other Snake River dams • Impacts from mainstem Columbia River and Snake River hydropower systems • Hatchery-related effects • Degraded estuarine and nearshore habitat.

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
Columbia River chum salmon	Threatened 6/28/05	NMFS 2013	NMFS 2022a; Ford 2022	This species has 17 populations divided into 3 MPGs. 3 populations exceed the recovery goals established in the recovery plan (Dornbusch 2013). The remaining populations have unknown abundances. Abundances for these populations are assumed to be at or near zero. The viability of this ESU is relatively unchanged since the last review (moderate to high risk), and the improvements in some populations do not warrant a change in risk category, especially given the uncertainty regarding climatic effects in the near future.	• Degraded estuarine and nearshore marine habitat • Degraded freshwater habitat • Degraded stream flow as a result of hydropower and water supply operations • Reduced water quality • Current or potential predation • An altered flow regime and Columbia River plume • Reduced access to off-channel rearing habitat in the lower Columbia River • Reduced productivity resulting from sediment and nutrient-related changes in the estuary • Juvenile fish wake strandings • Contaminants
Southern Oregon/ Northern California Coast coho salmon	Threatened 6/28/05	NMFS 2014	NMFS 2016b	This ESU comprises 31 independent, 9 independent, and 5 ephemeral populations all grouped into 7 diversity strata. Of the 31 independent populations, 24 are at high risk of extinction and 6 are at moderate risk of extinction. The extinction risk of an ESU depends upon the extinction risk of its constituent independent populations; because the population abundance of most independent populations are below their depensation threshold, the SONCC coho salmon ESU is at high risk of extinction and is not viable	• Lack of floodplain and channel structure • Impaired water quality • Altered hydrologic function • Impaired estuary/mainstem function • Degraded riparian forest conditions • Altered sediment supply • Increased disease/predation/competition • Barriers to migration • Fishery-related effects • Hatchery-related effects
Snake River sockeye salmon	Endangered 6/28/05	NMFS 2015	NMFS 2022d; Ford 2022	This single population ESU is at remains at “extremely high risk,” although there has been substantial progress on the first phase of the proposed recovery approach—developing a hatchery-based program to amplify and conserve the stock to facilitate reintroductions. Current climate change modeling supports the “extremely high risk” rating with the potential for extirpation in the near future (Crozier et al. 2020). The viability	• Effects related to the hydropower system in the mainstem Columbia River • Reduced water quality and elevated temperatures in the Salmon River • Water quantity • Predation

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
				of the Snake River sockeye salmon ESU therefore has likely declined since the time of the prior review, and the extinction risk category remains "high."	
Upper Columbia River steelhead	Threatened 1/5/06	Upper Columbia Salmon Recovery Board 2007	NMFS 2022b; Ford 2022	This DPS comprises four independent populations. The most recent estimates (five-year geometric mean) of total and natural-origin spawner abundance have declined since the last report, largely erasing gains observed over the past two decades for all four populations (Figure 12, Table 6). Recent declines are persistent and large enough to result in small, but negative 15-year trends in abundance for all four populations. The overall Upper Columbia River steelhead DPS viability remains largely unchanged from the prior review, and the DPS is at high risk driven by low abundance and productivity relative to viability objectives and diversity concerns.	• Adverse effects related to the mainstem Columbia River hydropower system • Impaired tributary fish passage • Degraded floodplain connectivity and function, channel structure and complexity, riparian areas, large woody debris recruitment, stream flow, and water quality • Hatchery-related effects • Predation and competition • Harvest-related effects
Lower Columbia River steelhead	Threatened 1/5/06	NMFS 2013	NMFS 2022a; Ford 2022	This DPS comprises 23 historical populations, 17 winter-run populations and 6 summer-run populations. 10 are nominally at or above the goals set in the recovery plan (Dornbusch 2013); however, it should be noted that many of these abundance estimates do not distinguish between natural- and hatchery-origin spawners. The majority of winter-run steelhead DIPs in this DPS continue to persist at low abundance levels (hundreds of fish), with the exception of the Clackamas and Sandy River DIPs, which have abundances in the low 1,000s. Although the five-year geometric abundance means are near recovery plan goals for many populations, the recent trends are negative. Overall, the Lower Columbia River steelhead DPS is therefore considered to be at "moderate" risk.,	• Degraded estuarine and nearshore marine habitat • Degraded freshwater habitat • Reduced access to spawning and rearing habitat • Avian and marine mammal predation • Hatchery-related effects • An altered flow regime and Columbia River plume • Reduced access to off-channel rearing habitat in the lower Columbia River • Reduced productivity resulting from sediment and nutrient-related changes in the estuary • Juvenile fish wake strandings • Contaminants

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
Upper Willamette River steelhead	Threatened 1/5/06	NMFS 2011	NMFS 2024; Ford 2022	This DPS has four demographically independent populations. Populations in this DPS have experienced long-term declines in spawner abundance. Although the recent magnitude of these declines is relatively moderate, continued declines would be a cause for concern. In the absence of substantial changes in accessibility to high-quality habitat, the DPS will remain at "moderate-to-high" risk. Overall, the Upper Willamette River steelhead DPS is therefore at "moderate-to-high" risk, with a declining viability trend.	• Degraded freshwater habitat • Degraded water quality • Increased disease incidence • Altered stream flows • Reduced access to spawning and rearing habitats due to impaired passage at dams • Altered food web due to changes in inputs of microdetritus • Predation by native and non-native species, including hatchery fish and pinnipeds • Competition related to introduced salmon and steelhead • Altered population traits due to interbreeding with hatchery origin fish
Middle Columbia River steelhead	Threatened 1/5/06	NMFS 2009b	NMFS 2022f; Ford 2022	This DPS comprises 17 extant populations. Recent (five-year) returns are declining across all populations, the declines are from relatively high returns in the previous five-to-ten-year interval, so the longer-term risk metrics that are meant to buffer against short-period changes in abundance and productivity remain unchanged. The Middle Columbia River steelhead DPS does not currently meet the viability criteria described in the Middle Columbia River steelhead recovery plan.	• Degraded freshwater habitat • Mainstem Columbia River hydropower-related impacts • Degraded estuarine and nearshore marine habitat • Hatchery-related effects • Harvest-related effects • Effects of predation, competition, and disease
Snake River basin steelhead	Threatened 1/5/06	NMFS 2017a	NMFS 2022g; Ford 2022	This DPS comprises 24 populations. Based on the updated viability information available for this review, all five MPGs are not meeting the specific objectives in the draft recovery plan, and the viability of many individual populations remains uncertain. Of particular note, the updated, population-level abundance estimates have made very clear the recent (last five years) sharp declines that are extremely worrisome, were they to continue.	• Adverse effects related to the mainstem Columbia River hydropower system • Impaired tributary fish passage • Degraded freshwater habitat • Increased water temperature • Harvest-related effects, particularly for B-run steelhead • Predation • Genetic diversity effects from out-of-population hatchery releases

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
Southern DPS of green sturgeon	Threatened 4/7/06	NMFS 2018	NMFS 2021	The Sacramento River contains the only known green sturgeon spawning population in this DPS. The current estimate of spawning adult abundance is between 824-1,872 individuals. Telemetry data and genetic analyses suggest that Southern DPS green sturgeon generally occur from Graves Harbor, Alaska to Monterey Bay, California and, within this range, most frequently occur in coastal waters of Washington, Oregon, and Vancouver Island and near San Francisco and Monterey bays. Within the nearshore marine environment, tagging and fisheries data indicate that Northern and Southern DPS green sturgeon prefer marine waters of less than a depth of 110 meters.	• Reduction of its spawning area to a single known population • Lack of water quantity • Poor water quality • Poaching
Southern DPS of eulachon	Threatened 3/18/10	NMFS 2017c	NMFS 2022h	The Southern DPS of eulachon includes all naturally-spawned populations that occur in rivers south of the Nass River in British Columbia to the Mad River in California. Sub populations for this species include the Fraser River, Columbia River, British Columbia, and the Klamath River. In the early 1990s, there was an abrupt decline in the abundance of eulachon returning to the Columbia River. Despite a brief period of improved returns in 2001-2003, the returns and associated commercial landings eventually declined to the low levels observed in the mid-1990s. Although eulachon abundance in monitored rivers has generally improved, especially in the 2013-2015 return years, recent poor ocean conditions and the likelihood that these conditions will persist into the near future suggest that population declines may be widespread in the upcoming return years.	• Changes in ocean conditions due to climate change, particularly in the southern portion of the species' range where ocean warming trends may be the most pronounced and may alter prey, spawning, and rearing success. • Climate-induced change to freshwater habitats • Bycatch of eulachon in commercial fisheries • Adverse effects related to dams and water diversions • Water quality, • Shoreline construction • Over harvest • Predation

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
Southern resident killer whale	Endangered 11/18/05	NMFS 2008	NMFS 2022k	The Southern Resident killer whale DPS is composed of a single population that ranges as far south as central California and as far north as southeast Alaska. While some of the downlisting and delisting criteria have been met, the biological downlisting and delisting 63 criteria, including sustained growth over 14 and 28 years, respectively, have not been met. The SRKW DPS has not grown; the overall status of the population is not consistent with a healthy, recovered population. Considering the status and continuing threats, the Southern Resident killer whales remain in danger of extinction.	• Quantity and quality of prey • Exposure to toxic chemicals • Disturbance from sound and vessels • Risk from oil spills
Sunflower Sea Star	Proposed Rule to List as Threatened 3/16/2023	NA	Lowry et al. 2022	From 2013-17 sea star wasting syndrome (SSWS) reached pandemic levels, killing an estimated 90%+ of the population. Impacts varied by region across the range of the species and generally progressed from south to north. By 2017, *P. helianthoides* was rare south of Cape Flattery, WA, where it had been conspicuous and ecologically important in the benthic marine ecosystems. Declines in coastal British Columbia and the Aleutian Islands exceeded at least 60%, and more likely 80%. Environmental factors (e.g. temperature, dissolved oxygen) likely contributed to the pandemic and continue to interact with the disease to suppress recovery. The species is facing a moderate risk of extinction over the foreseeable future.	• Disease – Sea Star Wasting Disease SSWD • Elevated Ocean Temperatures and other Climate Change related effects (correlated with SSWD) • Lack of Regulation on Climate Change • Lack of direct species protection

2.2.2 Status of the Critical Habitat

This section describes the status of designated critical habitat affected by the proposed action by examining the condition and trends of the essential physical and biological features of that habitat throughout the designated areas. These features are essential to the conservation of the ESA-listed species because they support one or more of the species' life stages (e.g., sites with conditions that support spawning, rearing, migration and foraging).

For most salmon and steelhead, NMFS's critical habitat analytical review teams (CHARTs) ranked watersheds within designated critical habitat at the scale of the fifth-field hydrologic unit code (HUC5) in terms of the conservation value they provide to each ESA-listed species that they support (NMFS 2005a). These full reports are incorporated by reference. The conservation rankings were high, medium, or low. To determine the conservation value of each watershed to species viability, the CHARTs evaluated the quantity and quality of habitat features, the relationship of the area compared to other areas within the species' range, and the significance to the species of the population occupying that area. Even if a location had poor habitat quality, it could be ranked with a high conservation value if it were essential due to factors such as limited availability, a unique contribution of the population it served, or is serving another important role.

For southern DPS green sturgeon, a team similar to the CHARTs — a critical habitat review team (CHRT) — identified and analyzed the conservation value of particular areas occupied by southern green sturgeon, and unoccupied areas necessary to ensure the conservation of the species (USDC 2009). The CHRT did not identify those particular areas using HUC nomenclature, but did provide geographic place names for those areas, including the names of freshwater rivers, the bypasses, the Sacramento-San Joaquin Delta, coastal bays and estuaries, and coastal marine areas (within 110 m depth) extending from the California/Mexico border north to Monterey Bay, California, and from the Alaska/Canada border northwest to the Bering Strait; and certain coastal bays and estuaries in California, Oregon, and Washington.

For southern DPS eulachon, critical habitat includes portions of 16 rivers and streams in California, Oregon, and Washington (USDC 2011). We designated all of these areas as migration and spawning habitat for this species.

A summary of the status of critical habitats, considered in this Opinion, is provided in Table 3 below.

Table 3. Critical habitat, designation date, federal register citation, and status summary for critical habitat considered in this Opinion

Species	Designation Date and Federal Register Citation	Critical Habitat Status Summary
Lower Columbia River Chinook salmon	9/02/05 70 FR 52630	Critical habitat encompasses 10 subbasins in Oregon and Washington containing 47 occupied watersheds, as well as the lower Columbia River rearing/migration corridor. Most HUC5 watersheds with PCEs for salmon are in fair-to-poor or fair-to-good condition (NMFS 2005a). However, most of these watersheds have some, or high potential for improvement. We rated conservation value of HUC5 watersheds as high for 30 watersheds, medium for 13 watersheds, and low for four watersheds.
Upper Columbia River spring-run Chinook salmon	9/02/05 70 FR 52630	Critical habitat encompasses four subbasins in Washington containing 15 occupied watersheds, as well as the Columbia River rearing/migration corridor. Most HUC5 watersheds with PCEs for salmon are in fair-to-poor or fair-to-good condition. However, most of these watersheds have some, or high, potential for improvement. We rated conservation value of HUC5 watersheds as high for 10 watersheds, and medium for five watersheds. Migratory habitat quality in this area has been severely affected by the development and operation of the dams and reservoirs of the Federal Columbia River Power System.
Snake River spring/summer-run Chinook salmon	10/25/99 64 FR 57399	Critical habitat consists of river reaches of the Columbia, Snake, and Salmon rivers, and all tributaries of the Snake and Salmon rivers (except the Clearwater River) presently or historically accessible to this ESU (except reaches above impassable natural falls and Hells Canyon Dam). Habitat quality in tributary streams varies from excellent in wilderness and roadless areas, to poor in areas subject to heavy agricultural and urban development (Wissmar et al. 1994). Reduced summer stream flows, impaired water quality, and reduced habitat complexity are common problems. Migratory habitat quality in this area has been severely affected by the development and operation of the dams and reservoirs of the Federal Columbia River Power System.
Upper Willamette River Chinook salmon	9/02/05 70 FR 52630	Critical habitat encompasses 10 subbasins in Oregon containing 56 occupied watersheds, as well as the lower Willamette/Columbia River rearing/migration corridor. Most HUC5 watersheds with PCEs for salmon are in fair-to-poor or fair-to-good condition. However, most of these watersheds have some, or high, potential for improvement. Watersheds are in good to excellent condition with no potential for improvement only in the upper McKenzie River and its tributaries (NMFS 2005a). We rated conservation value of HUC5 watersheds as high for 22 watersheds, medium for 16 watersheds, and low for 18 watersheds.
Snake River fall-run Chinook salmon	10/25/99 64 FR 57399	Critical habitat consists of river reaches of the Columbia, Snake, and Salmon rivers, and all tributaries of the Snake and Salmon rivers presently or historically accessible to this ESU (except reaches above impassable natural falls, and Dworshak and Hells Canyon dams). Habitat quality in tributary streams

Species	Designation Date and Federal Register Citation	Critical Habitat Status Summary
		varies from excellent in wilderness and roadless areas, to poor in areas subject to heavy agricultural and urban development (Wissmar et al. 1994). Reduced summer stream flows, impaired water quality, and reduced habitat complexity are common problems. Migratory habitat quality in this area has been severely affected by the development and operation of the dams and reservoirs of the Federal Columbia River Power System.
Columbia River chum salmon	9/02/05 70 FR 52630	Critical habitat encompasses six subbasins in Oregon and Washington containing 19 occupied watersheds, as well as the lower Columbia River rearing/migration corridor. Most HUC5 watersheds with PCEs for salmon are in fair-to-poor or fair-to-good condition (NMFS 2005a). However, most of these watersheds have some or a high potential for improvement. We rated conservation value of HUC5 watersheds as high for 16 watersheds, and medium for three watersheds.
Lower Columbia River coho salmon	2/24/16 81 FR 9252	Critical habitat encompasses 10 subbasins in Oregon and Washington containing 55 occupied watersheds, as well as the lower Columbia River and estuary rearing/migration corridor. Most HUC5 watersheds with PCEs for salmon are in fair-to-poor or fair-to-good condition (NMFS 2005a). However, most of these watersheds have some or a high potential for improvement. We rated conservation value of HUC5 watersheds as high for 34 watersheds, medium for 18 watersheds, and low for three watersheds.
Snake River sockeye salmon	10/25/99 64 FR 57399	Critical habitat consists of river reaches of the Columbia, Snake, and Salmon rivers; Alturas Lake Creek; Valley Creek; and Stanley, Redfish, Yellow Belly, Pettit and Alturas lakes (including their inlet and outlet creeks). Water quality in all five lakes generally is adequate for juvenile sockeye salmon, although zooplankton numbers vary considerably. Some reaches of the Salmon River and tributaries exhibit temporary elevated water temperatures and sediment loads that could restrict sockeye salmon production and survival (NMFS 2015b). Migratory habitat quality in this area has been severely affected by the development and operation of the dams and reservoirs of the Federal Columbia River Power System.
Upper Columbia River steelhead	9/02/05 70 FR 52630	Critical habitat encompasses 10 subbasins in Washington containing 31 occupied watersheds, as well as the Columbia River rearing/migration corridor. Most HUC5 watersheds with PCEs for salmon are in fair-to-poor or fair-to-good condition (NMFS 2005a). However, most of these watersheds have some or a high potential for improvement. We rated conservation value of HUC5 watersheds as high for 20 watersheds, medium for eight watersheds, and low for three watersheds.
Lower Columbia River steelhead	9/02/05 70 FR 52630	Critical habitat encompasses nine subbasins in Oregon and Washington containing 41 occupied watersheds, as well as the lower Columbia River rearing/migration corridor. Most HUC5 watersheds with PCEs for salmon are in fair-to-poor or fair-to-good condition (NMFS 2005a). However, most of these watersheds have some or a high potential for improvement. We rated conservation value of HUC5 watersheds as high for 28 watersheds, medium for 11 watersheds, and low for two watersheds.

Species	Designation Date and Federal Register Citation	Critical Habitat Status Summary
Upper Willamette River steelhead	9/02/05 70 FR 52630	Critical habitat encompasses seven subbasins in Oregon containing 34 occupied watersheds, as well as the lower Willamette/Columbia River rearing/migration corridor. Most HUC5 watersheds with PCEs for salmon are in fair-to-poor or fair-to-good condition (NMFS 2005a). However, most of these watersheds have some or a high potential for improvement. Watersheds are in good to excellent condition with no potential for improvement only in the upper McKenzie River and its tributaries (NMFS 2005a). We rated conservation value of HUC5 watersheds as high for 25 watersheds, medium for 6 watersheds, and low for 3 watersheds.
Middle Columbia River steelhead	9/02/05 70 FR 52630	Critical habitat encompasses 15 subbasins in Oregon and Washington containing 111 occupied watersheds, as well as the Columbia River rearing/migration corridor. Most HUC5 watersheds with PCEs for salmon are in fair-to-poor or fair-to-good condition (NMFS 2005a). However, most of these watersheds have some or a high potential for improvement. We rated conservation value of occupied HUC5 watersheds as high for 80 watersheds, medium for 24 watersheds, and low for 9 watersheds.
Snake River basin steelhead	9/02/05 70 FR 52630	Critical habitat encompasses 25 subbasins in Oregon, Washington, and Idaho. Habitat quality in tributary streams varies from excellent in wilderness and roadless areas, to poor in areas subject to heavy agricultural and urban development (Wissmar et al. 1994). Reduced summer stream flows, impaired water quality, and reduced habitat complexity are common problems. Migratory habitat quality in this area has been severely affected by the development and operation of the dams and reservoirs of the Federal Columbia River Power System.
Southern DPS of green sturgeon	10/09/09 74 FR 52300	Critical habitat has been designated in coastal U.S. marine waters within 60 fathoms depth from Monterey Bay, California (including Monterey Bay), north to Cape Flattery, Washington, including the Strait of Juan de Fuca, Washington, to its United States boundary; the Sacramento River, lower Feather River, and lower Yuba River in California; the Sacramento-San Joaquin Delta and Suisun, San Pablo, and San Francisco bays in California; tidally influenced areas of the Columbia River estuary from the mouth upstream to river mile 46; and certain coastal bays and estuaries in California (Humboldt Bay), Oregon (Coos Bay, Winchester Bay, Yaquina Bay, and Nehalem Bay), and Washington (Willapa Bay and Grays Harbor), including, but not limited to, areas upstream to the head of tide in various streams that drain into the bays. Several activities threaten the PBFs in coastal bays and estuaries and need special management considerations or protection. The application of pesticides, activities that disturb bottom substrates/ adversely affect prey resources/ degrade water quality through re-suspension of contaminated sediments, commercial shipping and activities that discharge contaminants and result in bioaccumulation of contaminants in green sturgeon; disposal of dredged materials that bury prey resources; and bottom trawl fisheries that disturb the bottom/prey resources for green sturgeon.

Species	Designation Date and Federal Register Citation	Critical Habitat Status Summary
Southern DPS of eulachon	10/20/11 76 FR 65324	Critical habitat for eulachon includes portions of 16 rivers and streams in California, Oregon, and Washington. All of these areas are designated as migration and spawning habitat for this species. In Oregon, we designated 24.2 miles of the lower Umpqua River, 12.4 miles of the lower Sandy River, and 0.2 miles of Tenmile Creek. We also designated the mainstem Columbia River from the mouth to the base of Bonneville Dam, a distance of 143.2 miles. Dams and water diversions are moderate threats to eulachon in the Columbia and Klamath rivers where hydropower generation and flood control are major activities. Degraded water quality is common in some areas occupied by southern DPS eulachon. In the Columbia and Klamath river basins, large-scale impoundment of water has increased winter water temperatures, potentially altering the water temperature during eulachon spawning periods. Numerous chemical contaminants are also present in spawning rivers, but the exact effect these compounds have on spawning and egg development is unknown. Dredging is a low to moderate threat to eulachon in the Columbia River. Dredging during eulachon spawning would be particularly detrimental.
Southern Resident killer whale	08/02/21 86 FR 41668	Critical habitat includes approximately 2,560 square miles of marine inland waters of Washington: 1) the Summer Core Area in Haro Strait and waters around the San Juan Islands; 2) Puget Sound; and 3) the Strait of Juan de Fuca. Six additional areas include 15,910 square miles of marine waters between the 20-feet (ft) (6.1-meter (m)) depth contour and the 656.2-ft (200-m) depth contour from the U.S. international border with Canada south to Point Sur, California. We have excluded the Quinault Range Site. Based on the natural history of the Southern Residents and their habitat needs, NMFS identified three PCEs, or physical or biological features, essential for the conservation of Southern Residents: 1) Water quality to support growth and development; 2) prey species of sufficient quantity, quality, and availability to support individual growth, reproduction and development, as well as overall population growth; and 3) passage conditions to allow for migration, resting, and foraging Water quality in Puget Sound, in general, is degraded. Some pollutants in Puget Sound persist and build up in marine organisms including Southern Residents and their prey resources, despite bans in the 1970s of some harmful substances and cleanup efforts. The primary concern for direct effects on whales from water quality is oil spills, although oil spills can also have long-lasting impacts on other habitat features In regards to passage, human activities can interfere with movements of the whales and impact their passage. In particular, vessels may present obstacles to whales' passage, causing the whales to swim further and change direction more often, which can increase energy expenditure for whales and impacts foraging behavior. Reduced prey abundance, particularly Chinook salmon, is also a concern for critical habitat.

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 project area is represented in Figure 1. The terrestrial boundaries of the action area include riverbanks and upland areas where construction would occur, such as at the anticipated transload facilit(ies)y and any upland portions of compensatory mitigation projects. For this consultation, the action area includes the project site and areas downstream to the mouth of the Columbia River, where salmonids exposed to contaminants at the project could occur.

The action area encompasses the locations where compensatory mitigation projects would be constructed. While specific locations have not yet been identified, they will be sited as close to the area of habitat loss as possible and may occur in the Lower Willamette River (including the Multnomah Channel) upstream to Willamette Falls, or the Lower Columbia River from Scappoose Bay to the upstream end of Hayden Island, consistent with the area considered by the Portland Harbor Trustee Council in the *Final Portland Harbor Programmatic Environmental Impact Statement and Restoration Plan* (NOAA Restoration Center 2017) to the extent practicable.

In addition, the action area includes the only U.S. Army Corps approved mitigation bank in the Portland Harbor Superfund Site, Lin ton Mill. Linnton Mill serves as a dual-credit, 30-acre mitigation bank that can be used to offset Natural Resource Damages (NRD) impacts as well as Clean Water Act credits. At full credit release, Linnton Mill will have restored off-channel habitat for juvenile ESA-listed salmon and steelhead.

Figure 1. Portland Harbor project footprint.

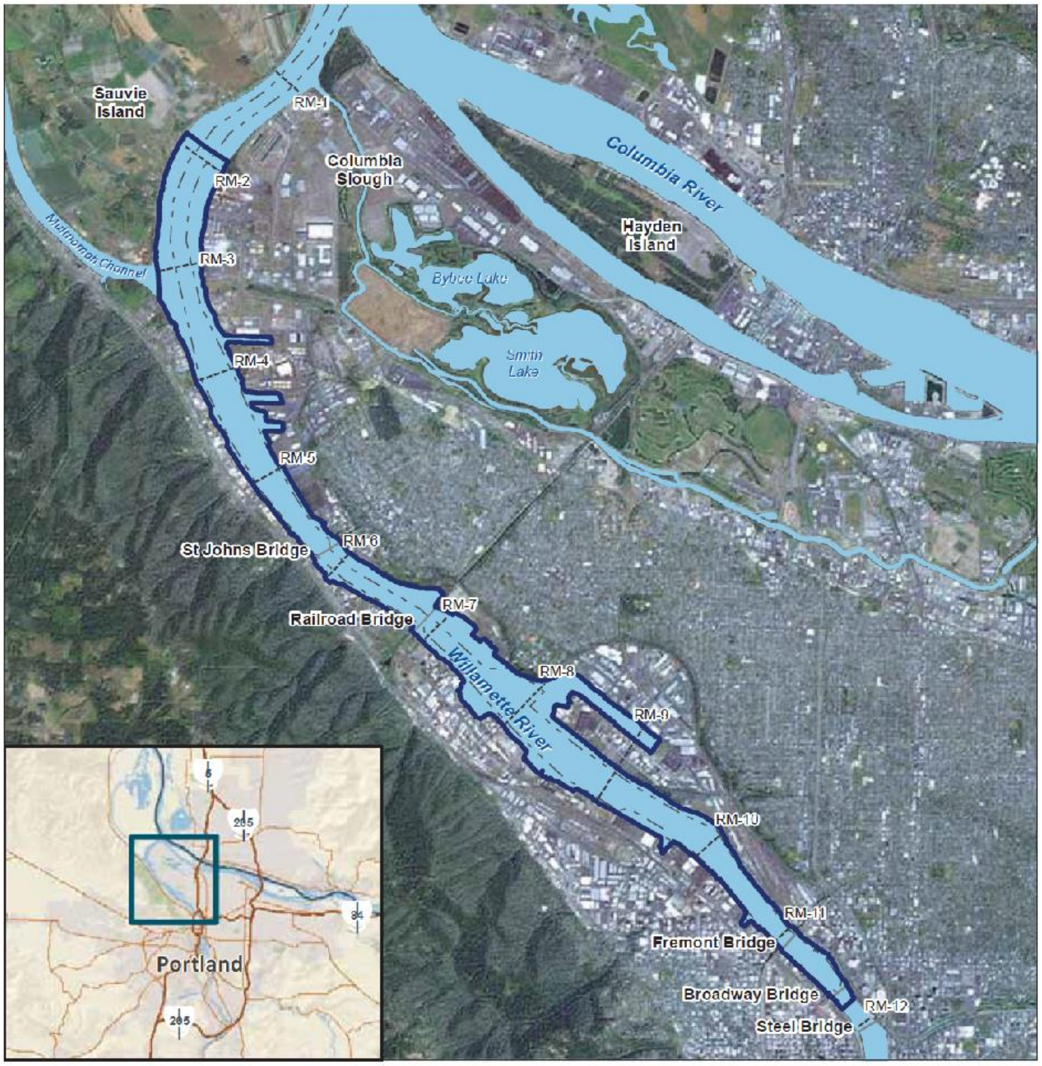
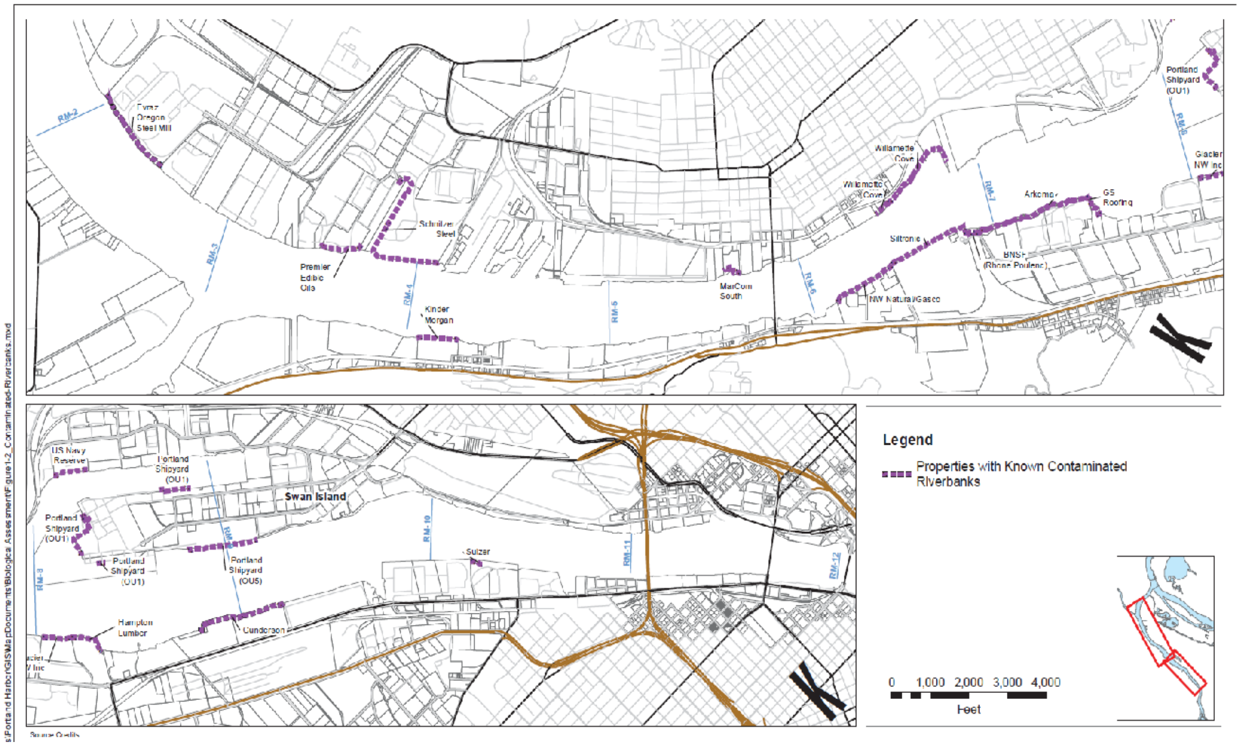


Figure 2. Riverbank remediation locations included in project footprint.



Remedial activities will occur in the project footprint in the Lower Willamette River from approximately RM 1.9 to 11.8, primarily below the water surface elevation but also including riverbanks in some areas. The EPA describes the action area in terms of magnitude of anticipated effects, based on proximity to the activity, from close proximity compliance points such as turbidity monitoring, to the mouth of the Columbia River. The effects of the action within the project footprint are the starting point for most of the effects that manifest elsewhere in the extended portion of the action area (the most likely exception for this is compensatory mitigation areas that occur outside of this remediation area).

The NMFS anticipates that dispersal of contaminants in suspended sediments from dredging, stormwater runoff from a transloading facility, and other remedial activities will dissipate relatively close to the project, and some contaminants are likely to eventually be transported to the mouth of the Columbia River. However, effects beyond the Willamette River (e.g., Lower Columbia River to the Pacific Ocean) are likely indistinguishable from other activities given the considerable dilution factor and other sources of anthropogenic stormwater and pollutants commonly found in stormwater within the Columbia River.

Contaminated materials will be conveyed from each transload facility to upland disposal landfills. The determination of upland disposal facilities locations will occur during the remedial design phase, but current options may include several Resource Conservation and Recovery Act (RCRA) Subtitle C and D landfills upstream of the Site on the Lower Columbia River. Transport of materials to the landfill and landfill operation is not part of the CERCLA action being considered in this Opinion.

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).

Climate change, discussed in detail above, is also considered as part of the baseline because it has affected and will continue to affect the status of ESA-listed species in the action area. Average annual temperatures increased by 0.6 to 0.8 degrees Celsius (°C) in the Pacific Northwest during the last century (Abatzoglou et al. 2014, Kunkel et al. 2013). Warming is likely to continue during the next century as average temperatures are projected to increase another 1.7 to 5.6°C, with the largest increases predicted to occur in summer (Mote et al. 2014). Climate models predict decreases in summer precipitation of as much as 30 percent by the end of the century (Mote et al. 2014) and increases in the frequency of severe winter precipitation events (i.e., 20- and 50-year events) in the western United States (Dominguez et al. 2012). For the Willamette River, Naik and Jay (2011) estimate a decrease in annual mean flow of 11.2 percent since the 19th century, with 9.3 percent due to climate change and 1.9 percent due to irrigation. For the Columbia River at The Dalles, they estimate a flow decrease of 8-9 percent due to climate change and 8 percent due to irrigation depletion; similarly, at the Columbia River estuary, climate change is responsible for a decrease of 9 percent and irrigation 6 percent (Naik and Jay 2011). The largest increases in winter flood frequency and magnitude are predicted in mixed rain-snow watersheds (Mote et al. 2014) as in the action area.

In addition to climate change, the Lower Columbia River floodplain, and many Pacific Northwest rivers have been modified by flood control dikes, thus changing access to shallow-water habitat vital to juvenile salmonids (Kukulka and Jay 2003). Spring freshet flow regulation has been most strongly altered, leading to an average decrease in shallow-water habitat of 62 percent between Columbia River rkm-50 to rkm-90. Historically, the floodplain was inundated regularly, whereas now shallow-water habitat is generally found only near the river channel (Kukulka and Jay 2003). Shallow-water habitat is important to juvenile salmonids for foraging as it provides food resources such as benthic macroinvertebrates, zooplankton, and emergent insects.

Habitat conditions within the Lower Willamette River are highly degraded. The streambanks have been channelized, off-channel areas removed, tributaries put into pipes, and the river disconnected from its floodplain as the lower valley was urbanized. Silt loading to the LWR has increased over historical levels due to logging, agriculture, road building, and urban and suburban development within the watershed. Limited opportunity exists for large wood recruitment to the LWR due to the paucity of mature trees along the shoreline, and the lack of relief along the shoreline to catch and hold the material. The LWR has been deepened and narrowed through channelization, diking and filling, and much of the shallow-water habitat (important for rearing juvenile salmonids) has been converted to deep-water habitat; 79 percent of the shallow-water through the lower river has been lost through historic channel deepening (Northwest Power and Conservation Council 2004). Most recently, the Federal Navigation Channel at Post Office Bar was dredged in October 2011. Additionally, much of the historical off-channel habitat (also important habitat for juvenile salmonids) has been lost due to diking and filling of connected channels and wetlands. Gravel continues to be extracted from the river and floodplain, and much of the sediment that would otherwise move downstream in the Willamette River is blocked by dams. All of these river changes contribute to the factors limiting recovery of ESA-listed salmonids using the action area.

The LWR through the City of Portland is highly developed for industrial, commercial and residential purposes. Much of the river is fringed by seawalls or riprapped embankments. Water quality in the action area reach of the Willamette River reflects its urban location and disturbance history. The LWR is currently listed on the Oregon Department of Environmental Quality (DEQ) Clean Water Act 303(d) List of Water Quality Limited Water Bodies. DEQ-listed water quality problems identified in the action area include toxins, biological criteria (fish skeletal deformities), bacteria (fecal coliform), and temperature. Sediment sampling in the action area has identified the presence of elevated levels of ammonia.

Conservation banks present a unique factual situation, and this warrants a particular approach to how they are addressed. Specifically, when NMFS is consulting on a proposed action that includes conservation bank credit purchases, it is likely that physical restoration work at the bank site has already occurred and/or that a section 7 consultation occurred at the time of bank establishment. A traditional reading of "environmental baseline," might suggest that the overall ecological benefits of the conservation bank actions therefore belong in the environmental baseline. However, under this reading, all proposed actions, whether or not they included proposed credit purchases, would benefit from the environmental 'lift' of the entire conservation bank because it would be factored into the environmental baseline. In addition, where proposed actions did include credit purchases, it would not be possible to attribute their benefits to the proposed action, without double counting. These consequences undermine the purposes of conservation banks and also do not reflect their unique circumstances. Specifically, conservation banks are established based on the expectation of future credit purchases. In addition, credit purchases as part of a proposed action will also be the subject of a future section 7 consultation. It is therefore appropriate to treat the beneficial effects of the bank as accruing incrementally at the time of specific credit purchases, not at the time of bank establishment or at the time of bank restoration work. Thus, for all projects within the service area of a conservation bank, only the benefits attributable to credits sold are relevant to the environmental baseline. Where a proposed action includes credit purchases, the benefits attributable to those credit purchases are considered effects of the action.

2.4.1 Species in the Action Area

Most of the component populations of LCR Chinook salmon, UCR spring-run Chinook salmon, SR spring/summer run Chinook salmon, UWR spring-run Chinook salmon, SR fall-run Chinook salmon, CR chum salmon, LCR coho salmon, SR sockeye salmon, LCR steelhead, MCR steelhead, UCR steelhead, SR steelhead, and UWR steelhead, are at a low level of abundance or productivity. Several species have lost multiple historical populations as a result of anthropogenic changes throughout their habitat, and all remaining populations face limiting factors in the remaining habitat, including in the action area. Individuals from almost all of the ESA-listed component populations must move through or utilize the action area at some point during their life history. They will encounter habitat conditions degraded by modified flow regime, reduced water quality from chemical pollution, loss of functioning floodplains and secondary channels, loss of vegetated riparian areas and associated shoreline cover, and loss of historical estuarine conditions. This degradation is reflected in limiting factors, including loss of spawning and rearing space, juvenile fish stranding, and increased predation.

Juvenile and adult Chinook salmon, coho salmon, and steelhead use the Willamette River within Portland Harbor as a migratory corridor and rearing habitat for juveniles (Friesen 2005). All populations of Upper Willamette River species use Portland Harbor, but only the Clackamas River populations of the Lower Columbia River species occur there. The results of the Friesen study demonstrate that juvenile salmon and steelhead are present in the LWR nearly year-round. Of the more than 5,000 juvenile salmonids collected during the study, over 87 percent were Chinook salmon, 9 percent were coho salmon, and 3 percent were steelhead. Friesen concluded that the Chinook salmon juveniles were largely spring-run stocks that rear in fresh water for a year or more before migrating to the ocean. Chinook salmon juveniles caught exhibited a bimodal distribution in length, indicating the presence of both subyearlings and yearlings. Although at lower abundance, coho salmon juveniles also exhibited this bimodal distribution of yearlings and subyearlings. The abundance of all juvenile salmon and steelhead increased beginning in November, peaked in April, and declined to near zero by July. Some of the larger juveniles may spend extended periods of time in off-channel habitat. Mean migration rates of juvenile salmon and steelhead ranged from 1.68 miles/day for steelhead to 5.34 miles/day for sub-yearling Chinook salmon. Residence time in the LWR ranged from 4.9 days for Chinook to 15.8 days for steelhead. Catch rates of juvenile salmon were significantly higher at sites composed of natural habitat (e.g., beaches and alcoves).

Friesen (2005) contradicts the longstanding assumption that Upper Willamette River Chinook salmon overwinter and grow in their natal streams, then pass quickly through the LWR corridor during a springtime migration toward the sea. Instead, he found juvenile hatchery and naturally-spawned Chinook salmon to be present and growing in the LWR during every month of the year, often at a faster rate than in other areas, although they were most abundant during winter and spring. In contrast, juvenile coho salmon and steelhead generally were rare except during winter and spring. Therefore, juvenile Chinook salmon will be present in the river during the proposed action, and there will likely be a few LCR coho salmon and steelhead juveniles present as well. Critical habitat in the action area provides a critical migration corridor and important rearing habitat with high conservation value.

Juvenile ESA-listed species also have a wide horizontal and vertical distribution in the Columbia River related to size and life history stage. Generally, juvenile salmonids will occupy the action area across the width of the river, and to average depths of up to 35 feet (Carter et al. 2009). Smaller-sized fish use the shallow inshore habitats and larger fish use the channel margins and main channel. The pattern of use generally shifts between day and night. Juvenile salmon occupy different locations within the Columbia River, and are typically in shallower water during the day, avoiding predation by larger fish that are more likely to be in deeper water; however, predation on juvenile salmonids by resident fish (northern pikeminnow, smallmouth bass) does not appear to have a significant impact. These juveniles will venture into the deeper areas of the river away from the shoreline, towards the navigation channel and along the bathymetric break, or channel margin, and will be closer to the bottom of the channel (Carter et al. 2009). The smaller sub-yearling salmonids will likely congregate along the nearshore areas in shallow water and extend into the channel margins (Bottom et al. 2011). Yet, as Carlson et al. (2001) indicated, there is a higher use of the channel margins than previously thought; relative juvenile position in the water column suggests higher potential sub-yearling use in areas of 20 to 30 feet deep.

Steelhead are not known to spawn in the mainstem of the Willamette River in the vicinity of the action area. Chinook salmon may spawn upstream of the action area in the lower end of the Clackamas River or in the Willamette River just below Willamette Falls, where suitable gravel-type substrate for spawning may occur, and in Johnson Creek. Recent observations of coho salmon juveniles in Miller Creek (a Willamette River tributary at RM 3) and in Johnson Creek by City of Portland biologists suggest that coho spawning may occur in small tributaries in the LWR. Adult Chinook salmon and steelhead have been documented holding in the LWR for some time before moving upriver. Adults migrate upstream to spawn during early spring (spring Chinook salmon), early fall (coho salmon), and late fall through winter (steelhead), and spawn in early to mid-fall (Chinook and coho salmon) and spring (steelhead). Adult steelhead have been documented entering the mouth of the Clackamas River with a darkened coloration, indicating that they have been in freshwater for some time.

UWR Chinook Salmon. The Willamette Major Population Group (MPG) consists of seven populations. Each of the seven populations must pass through the project footprint where construction effects will occur and the highest decrease in water quality and are therefore at risk of more acute effects from the program. Abundance levels for all but one of the seven demographically independent populations (DIPs) in this ESU remain well below their recovery goals. The Clackamas River DIP currently exceeds its abundance recovery goal (3,616 with a target of 2,317 fish) (Ford 2022). Alternatively, the Calapooia River may be functionally extinct, and the Molalla River remains critically low. With the exception of the Clackamas River, the proportions of natural-origin spawners in the remainder of the ESU are well below those identified in the recovery goals. Overall, there has likely been a declining trend in the viability of the Upper Willamette River Chinook salmon ESU since the last review. However, the magnitude of this change is not sufficient to suggest a change in risk category, so the Upper Willamette River Chinook salmon ESU remains at "moderate" risk of extinction.

UWR Steelhead. Each of the five populations pass through the project footprint. Populations in this DPS have experienced long-term declines in spawner abundance, and the underlying cause(s) of these declines is not well understood. Abundance and life history data for steelhead in the Upper Willamette River steelhead DPS are very limited. Therefore, the Upper Willamette River steelhead DPS is considered at "moderate-to-high" risk, with a declining viability trend (Ford 2022).

LCR Chinook Salmon. This ESU has six MPGs with 32 DIPs. Most populations are still far from the recovery plan goals, with only seven of 32 populations at or near the recovery viability goals set in the recovery plan, and 10 DIPs either had no abundance information (presumed near zero) or exist at very low abundances. The seven DIPs included one spring-run, five fall-run, and one late fall-run DIPs. Six of these seven DIPs were located in the Cascade stratum; most of the populations in the Coastal and Gorge strata are doing poorly. Many of the remaining populations still require substantial improvements in abundance to reach their viability goals. The Clackamas (fall-run) population, which must migrate through the project footprint and is at risk of more acute effects from the program, is between 10 and 50 percent of the recovery target for natural-origin spawner abundance (236 with a target of 1,551 fish), the second-lowest category in the report. Overall, the viability of the Lower Columbia River Chinook salmon ESU has increased somewhat since the last status review, although the ESU remains at "moderate" risk of extinction (Ford 2022).

The Clackamas population is considered a contributing population, which is a population targeted for some improvement in status so that the stratum-wide average viability is 2.25 or higher. Functionally, this is equivalent to about half of the populations in the MPG being viable, and a viable population is one whose persistence probability is high or very high, with a low or very low risk of extinction in 100 years.

LCR Coho Salmon. Overall abundance trends for LCR coho salmon are generally negative, due to decreases in natural spawner and total abundances across all DIPs. For individual populations, the risk of extinction spans the full range, from "low" to "very high." Only 6 of the 23 populations appear to be above their recovery goal. The Clackamas population, which must migrate through the project footprint and is at risk of more acute effects from the program, is less than 10 percent of the recovery target for natural-origin spawner abundance (2,889 with a target of 11,232 fish). The Clackamas population is considered a primary population, which is a population targeted for viability, meaning that it is targeted for restoration to high or very high persistence probability. The current extinction risk for LCR coho salmon is moderate.

LCR Steelhead. Two MPGs consist of 23 populations. The majority of winter-run steelhead populations persist at low abundance levels (100s of fish), with the exception of the Clackamas and Sandy River DIPs, which have abundances in the low 1,000s. The Clackamas River population, which must migrate through the project footprint and is at risk of more acute effects from the program, is between 10 and 50 percent of the recovery target for natural-origin spawner abundance (2,819 with a target of 10,671 fish), the second-lowest category (Ford 2022). The current extinction risk for the Clackamas River population is moderate. The Clackamas population is considered a primary population and is targeted for viability, meaning that it is targeted for restoration to high or very high persistence probability. Although the five-year geometric abundance means are near recovery plan goals for many populations, the recent trends are negative. Overall, the Lower Columbia River steelhead DPS is considered to be at "moderate" risk, and the viability is largely unchanged from the prior review.

MCR Steelhead. Of the four MPGs comprised of 17 populations, four are at high risk of extinction. Two of the four MPGs in this DPS include at least one population rated at "low" or "very low" risk for abundance and productivity, while the other two MPGs remain in the "moderate" to "high" risk range. Overall, the Middle Columbia River steelhead DPS remains at "moderate" risk of extinction, with viability unchanged from the prior review (Ford 2022).

CR Chum Salmon. A total of three of 17 populations exceed the recovery goals established in the recovery plan. The remaining populations have unknown abundances, including the Clackamas population, although it is reasonable to assume that the abundances are very low and unlikely to be more than 10 percent of the established recovery goal. Even with the improvements observed during the last five years, most DIPs in this ESU remain at a "very high" risk level. With so many primary DIPs at near-zero abundance, none of the MPGs could be considered viable. The Columbia River chum salmon ESU is at moderate risk of extinction.

SR Sockeye Salmon. This ESU is comprised of one extant population. The overall biological status relative to recovery goals is "high risk," and in terms of natural production it is at "extremely high risk." The viability of the Snake River sockeye salmon ESU has likely declined since the time of the prior review, and the extinction risk category remains "high."

SR Spring/Summer-run Chinook Salmon. This ESU is comprised of five MPGs with 28 populations. Of these populations, all except for three populations are at high overall extinction risk. Those three populations are at "maintained" risk; two "maintained" populations are in the Middle Fork Salmon River MPG, and one is in the Grande Ronde/Imnaha MPG. The Lower Snake, South Fork Salmon River, and Upper Salmon River MPGs are made up of populations with high risk. Overall, the Snake River spring/ summer-run Chinook salmon ESU continues to be at moderate-to-high risk.

SR Fall-Run Chinook Salmon. This ESU is comprised of one extant population (Lower Snake River) and one extirpated population (Middle Snake River). The extant population is at an overall "moderate" risk of extinction. Overall, the status of this ESU has improved since listing, but is still considered to be at a moderate-to-low risk of extinction, with viability largely unchanged from the prior review.

SR Steelhead. This ESU is comprised of five MPGs and 24 extant populations. Four of the 24 populations are at high risk of extinction, with the majority at "maintained," six populations at "viable" and one population "high viable." Overall, the DPS remains at "moderate" risk of extinction, with viability largely unchanged from the prior review.

UCR Spring-Run Chinook Salmon. The Upper Columbia River spring-run Chinook salmon ESU is comprised of three populations (Wenatchee River, Entiat River, and Methow River), each at high risk of extinction. The short-term patterns appear to be driven by years of poor ocean conditions. The ESU remains at high risk, with viability unchanged from the prior review.

UCR Steelhead. This ESU is comprised of four populations (Wenatchee River, Entiat River, Methow River, and Okanogan River), each at high risk of extinction. The short-term patterns appear to be driven by years with poor ocean conditions. The ESU remains at high risk, driven by low abundance and productivity relative to viability objectives and diversity concerns, with viability unchanged from the prior review.

Green Sturgeon. The southern DPS (sDPS) of green sturgeon is only present in the Lower Columbia River portion of the action area, and only the migrating subadult and adults are found during summer and fall (NMFS 2021a). No spawning occurs in the action area. Individuals from the sDPS of North American green sturgeon could migrate through and hold in deeper areas of the action area as subadults or adults mainly between July and September or October.

Eulachon. Eulachon spawning in the Sandy River and Columbia River tributaries upstream migrate through the Lower Columbia River portion of the action area. Adult and larval eulachon may be present in the Lower Columbia River from December to May each year, with peak spawning expected to occur in February or March (ODFW and WDFW 2009).

Sunflower Sea Star

The sunflower sea star occupies nearshore subtidal marine waters shallower than 450 meters (approximately 1400 feet) deep and is occasionally found in the deep parts of tide pools. Areas with substantial freshwater input, such as the Columbia River mouth, are known to have a lower likelihood of sunflower sea star occurrence.

2.4.2 Critical Habitat in the Action Area

The action area includes critical habitat for all of the species outlined in Section 2.4.1, Status of the Species in the Action Area. The four PBFs that are found in the action area include:

- Freshwater spawning sites with water quantity and quality conditions and substrate supporting spawning, incubation and larval development (NMFS 2005b)
- Freshwater rearing sites with water quality and floodplain connectivity that support juvenile growth and mobility, and sites with water quality and forage that support juvenile development, among other characteristics (NMFS 2005b).
- Freshwater migration sites that, among other things, are free of obstructions with water quantity and quality conditions that support juvenile and adult mobility and survival (NMFS 2005b).
- Estuarine areas free of obstruction with water quality, water quantity, and salinity conditions supporting juvenile and adult physiological transitions between fresh-and saltwater (NMFS 2005b).

Critical habitat conditions in the Lower Willamette River were highly degraded at the time NMFS designated critical habitat in 2005. Critical habitat baseline conditions have not changed on a Sitewide basis to date.

Similarly, habitat conditions in the Lower Columbia River are highly degraded from urbanization. Dams and other obstructions have weakened the river’s connection with its floodplain. Diversions have further altered flow patterns and reduced habitat complexity. The action area is water quality limited for temperature in the summer months and contaminants transported from throughout the watershed.

Existing water quality and forage within the project footprint are poor due to contamination. Migration corridors have existing in- and over-water structures, which create shaded areas where predatory species may hide and feed on out-migrating juvenile salmonids. Overwater structures may also prevent the growth and colonization of natural vegetation along the shoreline that can be used by juvenile salmon for rearing and refuge.

As described above, the critical habitat PBFs in the Lower Willamette River portion of the action area for salmon and steelhead are limited by several factors: high summer temperatures in the Lower Willamette River, the lack of floodplain connectivity, lack of shallow-water habitat, altered hydrology, lack of complex habitat to provide forage and cover, and the presence of hardened shorelines.

The Columbia River portion of the action area is designated as critical habitat for all salmonid ESUs and DPSs present in the action area, since it is used as a migration and rearing corridor for stocks accessing upstream spawning reaches. CR chum spawn in the mainstem Columbia River, and juvenile salmonids smolt in the estuary. As such, the PBFs discussed in the previous section for listed salmonid species also apply in the Lower Columbia River portion of the action area, along with spawning and estuarine areas.

The critical habitat PBFs in the Lower Columbia River portion of the action area are limited by several factors: high summer temperatures, degraded water quality from human land uses (agriculture, industry, and roads), the lack of floodplain connectivity, lack of shallow-water habitat, altered hydrology, lack of complex habitat to provide forage and cover, and the presence of hardened shorelines. The reduction in low energy, off-channel estuary habitat has reduced rearing habitat for Pacific salmon and steelhead (NMFS 2011c).

For green sturgeon and eulachon, critical habitat in the action area is limited to the Lower Columbia River. Estuarine area PBFs for green sturgeon include food resources, water flow, water quality, depth, and migratory corridors to support migration, aggregation and holding, and feeding by subadult and adult green sturgeon. Relevant eulachon PBFs are freshwater spawning and incubation sites and freshwater and estuarine migration corridors, both with water flow, quality, and temperature conditions to support these life stages.

2.5. Effects of the Action

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

Within those areas subject to remediation actions in the project footprint, the action will affect freshwater migration corridors and freshwater rearing areas for LCR Chinook salmon, UWR Chinook salmon, LCR steelhead, and UWR steelhead. Specifically, the action will affect water quality, forage, and migration corridors free of obstruction.

As with most programmatic actions under ESA section 7 consultation, the program relies on using a set of minimization measures prescribed to address the various underlying effects of the actions described in Section 1. For this program, the action agency proposes a list of PDCs to elicit specific environmental outcomes, including those adverse effects on listed species and critical habitats under consultation. The PDCs are prescriptive, requiring specific actions to minimize and mitigate environmental effects, including those on the functions that create and maintain habitat supporting the ecological needs of the species in the action area. Doing so enables NMFS to determine which effects the species and critical habitat will be exposed to, and we will analyze how species and critical habitats will respond to those exposures and the risks associated with those exposures and responses. Each individual project covered under this Opinion will be completed with full application of the PDCs at each stage from pre-construction, construction, operation, or maintenance, and offsets for unavoidable habitat impacts.

The intensity of the effects on species and their critical habitat, in terms of changes in the condition of individual fish and PBFs and the number of individuals affected, and the severity of these effects, in terms of recovery time, will vary somewhat between projects because of differences at each site in the scope of work area isolation and construction, the particular life history stages present, the baseline condition of each fish present, and factors responsible for those conditions. The nature of these effects will be similar between projects because each project is based on a similar set of underlying construction activities that are limited by the same PDCs, and the individual salmon and steelhead have relatively similar life history requirements and behaviors regardless of species. No project will have effects on fish or PBFs that are greater than the full range of effects described below.

Under the program, the EPA will likely approve the implementation of no more than three remedial action projects simultaneously. In addition, no area shall be capped while (i.e., at the same time) an area directly adjacent, whether upstream or downstream, is completing dredging. In general, most consequences of the proposed action are temporary; either ephemeral (instantaneous to hours) or short-term (days to months). Some effects may extend years to decades or for the life of the project. Projects requiring more significant construction are likely to adversely affect more fish and to take a longer time to recover than projects with less construction. However, larger projects are also likely to have correspondingly greater conservation benefits because they are more likely to involve larger cleanup efforts and also include conservation measures to offset unavoidable impacts on habitat. Although no project will have solely detrimental effects, projects that have a larger remediation component are likely to have the greatest benefits.

Effects of Construction Activities

Construction activities in this opinion include the following activities including: dredging, excavation, enhanced natural recovery (ENR), capping, construction and decommissioning of the transload facilit(ies)y pile driving and removal, and debris and structure removal, or other benthic or shoreline disturbance necessary to carry out remediation activities. The function of most PBFs that are impaired at the site by any project completed under this opinion will be impaired for weeks or months and up to three years in some instances, and will affect an individual project action area. However, some impacts on benthic habitat that are expected to occur through dredging or capping, bank or channel hardening, and stormwater runoff may require longer recovery times, or persist for the life of the project; for example, caps that will require ongoing maintenance for the duration of their existence. In some cases, those impacts will continue to affect the quality and function of PBFs. Where these effects are identified, compensatory mitigation is required, regardless of whether habitat is lost temporarily or permanently.

Turbidity generated from pile driving or removal is temporary and confined to the area close to the operation. NMFS expects that some individual Chinook salmon and steelhead, both adult and juvenile, may be harassed by turbidity plumes resulting from pile driving or removal. Indirect lethal take can occur if individual juvenile fish are preyed on when they leave the work area to avoid temporary turbidity plumes. The requirements for completing the work during the preferred in-water work window will minimize the effects of turbidity on listed species. Benthic invertebrates in shallow-water habitats are key food sources for juvenile salmonids during their out-migration. New pilings may reduce the substrate available to benthic aquatic organisms and, therefore, the food available for juvenile salmonids in the project area. NMFS believes some effect on salmon and steelhead productivity may occur due to suppression of benthic prey species. Most existing commercial dock structures have a high density of existing piles and are not likely to provide significant habitat for listed salmonids. Further, listed salmonids must migrate by such structures. This likely takes place in an area of diminished light intensity and deeper water along the outer margin of the structure, where they may have higher predation.

The installation and removal of piling with a vibratory or impact hammer is likely to result in adverse effects to ESA-listed species considered in this Opinion due to high levels of underwater sound that will be produced. The number of piles needed will vary with the size and type of pile used, site conditions, substrate, driving method, load generated by the bridge and traffic, and other considerations. Pile installation proceeds intermittently at a rate of 5 to 10 pile per day spread across 1 to 40 days of a typical in-water work window, or for a shorter period split between two work seasons per project.

Although there is little information regarding the effects on fish from underwater sound pressure waves generated during the piling installation (Anderson and Reyff 2006; Laughlin 2006), laboratory research on the effects of sound on fish has used a variety of species and sounds (Hastings *et al.* 1996; Popper and Clarke 1976; Scholik and Yan. 2002). Because those data are not reported in a consistent manner and most studies did not examine the type of sound generated by pile driving, it is difficult to directly apply the results of those studies to pile driving effects on salmon, steelhead, and sturgeon. However, it is well established that elevated sound can cause injuries to fish swim bladders and internal organs and temporary and permanent hearing damage. These effects are presumed to extend across the stream channel regardless of width, and as far as the sound wave can travel within the line of site upstream and downstream for a total distance that varies with stream sinuosity and width, water depth, pile characteristics, pile driving technology, and sound attenuation methods used.

The degree to which normal behavior patterns are altered by pile driving is less known, although it is likely that ESA-listed fish considered in this opinion that are resident within the action area are more likely to sustain an injury than fish that are migrating up or downstream. Removal of pilings within the wetted perimeter that are at the end of their service life will disturb sediments that become suspended in the water, often along with contaminants that may have been pulled up with, or attached to, the pile. A release of PAHs into the water is likely to occur if creosote-treated pilings unnecessarily damaged during removal, or if debris is allowed to re-enter or remain in the water.

The EPA proposed PDCs to minimize exposure of fish to high levels of underwater sound during pile driving and to increased suspended solids and contaminants during pile removal. Those include requirements that pilings must be 36 inches in diameter or smaller, steel H-pile must be designated as HP24 or smaller, a vibratory hammer must be used whenever possible for piling installation, and full or partial (bubble curtain) isolation of the pile while it is being driven. Drilled shafts have not been shown to have underwater sound impacts to fish due to low decibels. Depending on substrate type the initial drilling with the casing can have a small pulse of turbidity. During pile extraction, care will be taken to ensure that sediment disturbance is minimized, including special measures for broken or intractable piles, all adhering sediment and floating debris are contained, and all residue is properly disposed. Nonetheless, it is still likely that sound energy will radiate directly or indirectly into the water as a result of pile driving vibrations, although widespread propagation of sounds injurious to fish is not expected to occur, and that a small contaminant release will occur when a creosote pile is removed, and total suspended sediment will increase with every pile removal.

Dredging and excavation are expected to affect the largest portion of the action area in the Lower Willamette River. Dredging will affect approximately 238 acres, including 28 acres of shallow-water habitat (areas of the project footprint less than 20 ft deep) and 58 acres within active channel margin (the area bounded by ordinary low and high-water marks). Capping is expected to cover approximately 110 acres, 50 acres of which is shallow-water habitat and 7.8 acres in active channel margin. Of all remedies proposed in the program, dredging has the potential to result in significant adverse consequences related to water quality, turbidity, suspended particulate levels in the water column (particularly in near-bottom waters), and decreased dissolved oxygen. The majority of solid-phase material resuspended during dredging is expected to settle out near the work area; however, some suspended sediments laden with chemical contaminants are likely to disperse downstream as far as the mouth of the Lower Columbia River. Loss of benthic species and habitat is expected. It can take weeks to years until benthic communities recolonize and re-stabilize. In some situations (e.g., capping), benthic communities may be permanently lost or repeatedly disturbed during ongoing maintenance, and mitigation will be required to offset effects. Long-term benefits are expected from the removal of contaminated areas, which will improve water quality across the site and downstream. These long-term benefits are also considered when determining the level of mitigation necessary to offset adverse effects of the proposed action.

Enhanced natural recovery is expected at 28 acres in the area of Swan Island Lagoon with four acres in shallow-water habitat and two acres occurring within the active channel margin. Impacts include increased turbidity and loss of benthic habitat and benthic species during and immediately following remedial activities. ENR is expected to provide a clean substrate base for recolonization of benthic communities, generally occurring over the course of weeks to years. During the recolonization period, forage opportunities for juvenile salmonids migrating downstream may be diminished. Long-term effects include a reduction in contamination as organic carbon in the ENR binds with COCs and less uptake of bio-accumulative contaminants by foraging salmonids.

An estimated 22,600 linear feet of contaminated riverbank will be excavated and subsequently capped. Short-term effects include an increase in erosion and turbidity, as well as temporary loss or disruption to riparian and nearshore habitat. Long-term effects of shoreline hardening or repair of an existing hardened shoreline include prevention of natural channel migration and perpetuation of a lack of floodplain connection and off-channel habitat access. Where site restoration to improve or replace habitat is not possible, permanent habitat loss can be expected, and conservation offsets would be required. Cap maintenance, which is required for the life of the cap, may include periodic disturbance of native material that has covered the cap over time, or material that was placed on top of the cap to simulate natural material to speed recovery of habitat function. Repeated disturbance of caps via placement of additional material to fortify compromised caps, and for cap sampling, will disturb individual fish using the area for rearing and/or migration. This ongoing activity will also disrupt benthic habitat and forage activity for juveniles.

The construction, operation and decommissioning of transload facilities within or near the Site will have both in-water and upland components and will be a source of construction noise and increased stormwater runoff. This action will also cause permanent loss of benthic habitat and aquatic vegetation, increase predator refugia, and will increase avoidance behavior for salmonids due to barge traffic. Though any facility would be constructed according to SLOPES-STU stormwater management specifications, treatment is an impact minimization measure, and most stormwater treatments are not able to remove 100% of all chemical constituents from the water. Treated stormwater that enters the Willamette River will travel downstream into the Columbia River, either depositing what chemical constituents remain after treatment into the sediment or remaining suspended as it travels further downstream. Downstream effects of the project's contribution to stormwater become undiscernible from any other project in the same action area, which also contributes to stormwater runoff. However, the project will nonetheless contribute to stormwater inputs and to the accrual of associated chemical constituents within the critical habitat and individual fish as they are taken up through the food chain.

As discussed in the proposed action, following the execution of the remedial design and the associated sediment removal, capping, construction, and any mitigation construction, the affected sites will need to be monitored for effectiveness over the long term. Additional sampling activities to monitor specific metrics (e.g., sediment contaminant concentrations, water chemistry, resident fish tissue contaminants, etc.) will occur at regularly scheduled intervals and may also be conducted on an as-needed basis in response to monitoring data.

The action agency, applicant, or contractors will monitor conditions at 2,165 acres total, including approximately 1,790 acres of MNR area, 138 acres in shallow habitat, and 115 acres in active channel margin. During monitoring, increased toxicity (accidental leaks/spills from equipment) and disturbance from sampling activities (vehicle/equipment traffic) is expected to impact water quality. These effects can be expected preconstruction, during remedial work, and long-term recurring every five years after project completion. Fish tissue samples will also be collected to track the goals of remediation. While resident fish (bass, crappie, and walleye) are the expected target, incidental take of listed fish species is possible during sampling.

Compensatory Mitigation

Compensatory mitigation projects will be constructed as part of the proposed action to comply with CWA 404(b)(1) removal/fill requirements and to offset project impacts to ESA-listed fish. The EPA and NMFS will consider the benefits of compensatory mitigation when reviewing the compensatory mitigation plans prior to implementation. To the extent practicable, compensatory mitigation projects will take place adjacent to the project requiring the offset. Project construction will result in the resuspension of contaminants in the water column, increased turbidity, and decreased dissolved oxygen in areas with higher contamination concentrations. Temporary effects from noise during construction and loss of benthic habitat and benthos species are expected. These projects must follow the construction PDCs. Long-term benefits are expected for forage, natural cover, and floodplain connectivity.

2.5.1 Effects of the Action on Species

Individuals of many ESA-listed salmon and steelhead species utilize the project footprint to fully complete the migration, spawning and rearing parts of their life cycle. They are, therefore, at risk of more acute effects from the program. Salmon and steelhead, southern green sturgeon, and eulachon migrate through and/or rear in the program action area. All UWR Chinook salmon and UWR steelhead must migrate through the action area as both juveniles and adults, and populations of LCR Chinook salmon, LCR steelhead and LCR coho salmon that spawn in the Clackamas River must also pass through the project footprint as juveniles and adults; therefore, individuals from these populations are reasonably likely to be affected by the proposed action. All other salmonids, as well as southern green sturgeon and eulachon, are impacted by the proposed action because they migrate through and/or rear in the Lower Columbia River and may, therefore, encounter increased contaminants that would not otherwise occur if not for the proposed action.

Depending on whether the salmon species has a stream or ocean-type life history, the ESUs may spend more or less time in the action area and experience different levels of impacts from the program. Salmonids generally exhibiting stream-type life history include LCR Chinook salmon (spring runs), LCR steelhead, LCR coho salmon, MCR steelhead, UWR steelhead, UWR Chinook salmon, SR spring/summer Chinook salmon, UCR Chinook salmon, SR steelhead, SR sockeye, and UCR steelhead. These juvenile fish migrate quickly downstream passing the action area within one to two days (Dawley et al. 1986). Similarly, in an unpublished study, a small sample size of 16 subyearling fall Chinook salmon had residence time in the lower Willamette River (RM 3.5 to RM 18.5) that ranged between 1.2 days and 6.8 days. Salmon generally exhibiting ocean-type life histories include LCR Chinook salmon (fall runs), CR chum salmon, and SR fall-run Chinook salmon. These fish are generally smaller (less than 100 mm) and more likely to spend days to weeks residing in tidal freshwater habitats in the action area, with peak abundances occurring from March through May (Hering et al. 2010, McNatt et al. 2016).

Project design criteria are intended to minimize the adverse effects of the proposed action on fish that could be directly or indirectly impacted via take pathways associated with construction, ongoing maintenance, and monitoring. Limiting in-water work to the current ODFW-recommended in-water work window will minimize direct exposure of fish to adverse effects of the proposed action. The current work window for the Willamette River is July 1- October 31 and December 1- January 31 (the winter work window is only for activities below -20' National Geodetic Vertical Datum 1947). The Oregon guidelines for the timing of in-water work are primarily based on the average run timing of salmon and steelhead populations, although the actual timing of each run varies from year to year according to environmental conditions. Because populations of salmon and steelhead have evolved different run timings, work timing becomes less effective as a measure to reduce adverse effects on species when two or more populations occur in a particular area. Work windows are generally designed to prevent work from occurring during peak presence of salmonids, but do not guarantee that exposure will not occur.

During the proposed in-water work window, it is likely that some juveniles will be rearing in the action area; upstream migrating Chinook adults are likely to be present in July, and upstream migrating coho adults are likely to be present in October. Adult salmonids would be moving quickly through the action area in the Lower Willamette River and, based on migration studies, are not expected to spend more than two days in the Lower Willamette River. The more sensitive and vulnerable juvenile life stage from the Upper Willamette River ESUs/DPSs, the Lower Columbia River ESUs/DPSs, and Lower Columbia River coho salmon ESU, may be present in the action area. However, densities are lower in the summer months compared with the winter months, and the summer in-water work window is designed to avoid peak smolt out-migration and peak adult migration for both Chinook salmon and steelhead (Friesen 2005). The specific length of time individuals spend within the Site is unknown due to difficulties in tagging such small fish. However, their presence in the action area is assumed. Subyearling Chinook salmon are found within the Site throughout most of the year, including in small numbers between the beginning of July and the end of October. Tagging studies indicate that smaller subyearling fish (30 to 70 mm) would be more shoreline oriented and spend more time within the action area than larger subyearling fish, which may spend as little as four days. Some migrating juvenile salmonids likely transit through the Site rapidly (approximately three days), limiting the probable exposure timeframe to acute intervals. Other juvenile salmonids may spend weeks or longer in the Site to feed and grow before transitioning to the Lower Columbia River estuary. Juvenile Chinook will have the most exposure due to their extensive use of nearshore habitats.

Effects of construction activities on species

Chemical contaminants resuspended during cleanup activities such as dredging, capping, pile driving, and pile removal, in addition to construction and stormwater runoff from the transload facilities, may impair orientation, migration and reproductive behavior. The impact of poor water quality depends on the amount and duration of exposure. Resuspension of anoxic sediments may result in reduced dissolved oxygen, which may impact adult salmon, as migration requires high expenditures of energy and, therefore, adequate levels of DO (Carter 2005). However, salmonids have been reported to actively avoid areas with low DO concentrations (Davis 1975 as cited in Carter 2005).

The exposure of juvenile and adult salmon and steelhead to increased turbidity and changes in substrate character from sediment generated by the proposed action is reasonably certain to elicit significant responses from a relatively small number of salmon and steelhead occupying the area. Salmon and steelhead would likely respond to the increased suspended sediment by attempting to move to locations with lower concentrations of fine sediment. Failure to avoid increased suspended sediment is likely to result in gill irritation or abrasion, which can reduce respiratory efficiency or lead to infection, and a reduction in juvenile feeding efficiency due to reduced visibility. Compromised gill function is likely to increase juvenile mortality.

An increase in turbidity from suspension of fine sediments can adversely affect fish and filter-feeding macro-invertebrates downstream from the action area. At moderate levels, turbidity has the potential to reduce primary and secondary productivity; at higher levels, turbidity may interfere with feeding and may injure and even kill both juvenile and adult fish (Berg and Northcote 1985, Spence et al. 1996).

Suspended sediment of the amount likely to be generated by the proposed action is very unlikely to kill exposed fish. Generally, increased turbidity can cause gill tissue damage; however, the concentration of suspended sediment that would result from this work is unlikely to be high enough for gill damage to occur. Turbidity may also cause physiological stress, affecting immune competence, growth, and reproductive success (Bash et al. 2001) and reduce the ability to tolerate additional stressors.

The transload facilities may result in increased stormwater runoff and increased contaminant burden to the Lower Willamette River. Exposure to elevated noise levels from construction activities can cause a temporary shift in hearing sensitivity (referred to as a temporary threshold shift), decreasing sensory capability for periods lasting from hours to days (Turnpenny et al. 1994, Hastings et al. 1996). Temporary threshold shifts reduce the survival, growth, and reproduction of the affected fish by increasing the risk of predation and reducing foraging or spawning success. Although no holding or spawning are likely to occur within the project footprint, pre-spawning mortality and less spawning success may occur upstream and downstream of long-term cleanup sites due to higher bioenergetic cost, more sublethal effects of contaminants, less adaptive behavior and movement, and an increased likelihood of competition, predation, and disease.

Because the EPA is likely to approve the implementation of no more than three remedial action projects to occur simultaneously, and limits on dredged material transload exist under the proposed action, the effects described above are likely to occur at a very limited number of sites in any given year. In the long term, we expect improved pre-spawning survival and spawning success after remediation and site restoration are complete due to less disease-induced morality, improved migration conditions and improved water quality.

Juvenile salmonids are expected to experience the effects described for adults, plus greater effect due to spending more time in the action area at a sensitive life stage. The impact of poor water quality depends on the amount and duration of exposure. Chemical contaminants in sediment and stormwater runoff impair orientation and migratory behavior, reduce feeding rate or success, and reduce survival. Larger juvenile salmonids are more tolerant to suspended sediment than smaller juveniles (Servizi and Martens 1991, Newcombe and Jensen 1996). Reduced dissolved oxygen may occur due to the resuspension of anoxic sediments, which may impact juvenile salmonids through adverse effects to growth, food conversion efficiency, and swimming performance (Bjornn and Reiser 1991); however, salmonids have been reported to actively avoid areas with low dissolved oxygen concentrations (Davis 1975 as cited in Carter 2005). The transload facilities may result in increased stormwater runoff and increased contaminant burden to the Lower Willamette River, and stormwater contaminants can result in adverse effects on salmonids that can accumulate in the prey and tissue of juvenile salmonids, resulting in a variety of lethal and sublethal effects. Direct mortality from suspended sediment is considered to be very unlikely, though turbidity may cause gill tissue damage and physiological stress, which may affect an organism's immune competence, growth, and reproductive success (Bash et al. 2001) and reduce its ability to tolerate additional stressors. Juvenile salmonids escaping poor water quality from work zones may be more vulnerable to predators, experience changes in migratory behavior and changes in feeding (Servizi 1988).

Dredging, capping, in situ treatment, and ENR will temporarily or permanently reduce the availability of benthic prey items for salmon and steelhead, reducing growth. Recovery times for benthic communities following dredging activities are expected to be on the order of months. For caps and in situ treatment, the benthic community would be permanently displaced, unless appropriate habitat layers can be incorporated into the constructed remedy. The annual amount of area with reduced benthic forage due to in-water construction and dredging is very small when compared to the available habitat in action area, even in its current degraded condition. Juvenile Chinook and coho diets may also be more tied to water column forage species (e.g., Daphnia *sp.*) than to benthic prey items (ODFW 2005), thus limiting only one source of prey. Therefore, disturbances to benthic habitat may not reduce some but not all juvenile salmonid forage opportunities within the project area.

Construction noise may affect juvenile salmonid migration and foraging. Pile installation activities are the most likely to elevate in-water noise, and the construction of the transload facility(ies)y represents the most extensive pile-driving activity that could occur under the proposed action, and it is assumed the vibratory hammer method would be used. Most juveniles are expected to avoid noisy areas, but some individuals may enter the area and respond to exposure by expressing increased stress levels. As explained in detail in the previous section, exposure to elevated noise levels can cause a temporary shift in hearing sensitivity that can increase the risk of predation and reduce foraging success. Very few fish are expected to die as a result of exposure to construction noise; a small number of fish may experience a loss of fitness as a result of this exposure. Pile driving would be conducted within the in-water work window to minimize the number of fish that may be affected by construction noise.

Entrainment may occur from the use of silt curtains or sheet pilings, although fish that are present within work areas during construction would be expected to avoid or rapidly move away from construction areas and other locations of active disturbance. Entrainment may also occur during the efforts associated with fish tissue sampling during MNR monitoring.

The proposed action includes continued use of existing in- and overwater structures in the action area and construction of new transload facilities. In-water and overwater structures adversely affect fish by impairing freedom of movement, creating predator refugia, interrupting forage behavior, and reducing aquatic vegetation and benthic productivity. Juvenile salmonids are known to avoid shaded areas, and, therefore, enter deeper water where forage efficiency is reduced and vulnerability to predators increases. Fish migration within the action area may be impacted, to an unknown extent, by artificial structures such as docks and pilings. Under the proposed action, piles and dilapidated structures with low function, permanence, and lifespan may be removed, resulting in a beneficial effect. Structures with medium to high function, permanence, and lifespan are expected to remain in place. Transload facilities may impact migration for shoreline-oriented juvenile salmonids and adult fish that would need to swim around associated in-water structures. Temporary docks are expected to be relocated to allow access to contaminated material, and depending on location or timing may have a detrimental or beneficial effect on migration. Depending on the size and nature of the clean-up efforts, temporary docks may remain in place for several months to several years. Compensatory mitigation due to construction activities is expected to offset the associated adverse effects.

The construction of new in-water/overwater structures associated with the transload facilities may cause migration delays for juvenile salmonids and increase the amount of shading around those structures, thereby increasing predation by creating predator refugia. Shading also can inhibit growth of aquatic vegetation and phytoplankton, reducing habitat complexity and juvenile salmon prey abundance (Kahler et al. 2000). The proposed action includes removal of some existing structures which may reduce shading and improving aquatic vegetation and phytoplankton growth. Each transload facility will likely expose salmonids to longer-term effects from chemical constituents carried into the water via stormwater runoff; however, those effects are likely to be minimized through stormwater management measures, which are built into the proposed action.

Long-term effects of the remediation process will improve sediment quality in the Lower Willamette River portion of the action area by removing contaminants through dredging and/or capping. Dredging in shallow water zones that convert shallow habitat to deep water would further degrade listed salmonid species’ access to important shallow-water habitats; however, most areas would be backfilled to grade to avoid permanent impacts. Capping of contaminants would require dredging for a net zero bathymetry change, or by not dredging the cap would increase the shallow-water habitat. Dredging and capping activities could remediate areas with existing debris or silt-dominated substrate by placing sand or gravel substrate as the final surface material. Sand and gravel generally produce more complex benthic communities than silt-dominated substrates. Compensatory mitigation projects would be required to offset any lost function

The water quality effects described within the project footprint above will pervade the rest of the action area, albeit to the same or lesser extent than in the project footprint. Though the action area extends well downstream of the project site, we do not expect there will be direct effects on salmon in the Lower Columbia River due to construction noise, disturbance, or entrainment. However, fish migrating through the Lower Columbia River could be exposed to the effects of stormwater runoff from increased contributing impervious surface resulting from the construction of transload facilities, and by increased suspended contaminants in the sediment that will enter the water column during dredging, capping, and pile driving activities. Water quality effects flowing downstream can reduce survival of eggs in redds for some years in some limited areas where fine sediment or chemical contaminant deposition accrues. Deposition reduces the availability of interstitial space and delivery of sufficient oxygen to incubating embryos. Where fine sediments is not deposited, or after it is scoured, more normal egg development is likely to occur due to improved water quality.

Because the EPA will likely approve the implementation of no more than three remedial action projects to occur simultaneously, and limits on dredged material transload exist under the proposed action, the effects described above will occur at a very limited number of sites in any given year. Juvenile salmonids are currently exposed to potentially lethal concentrations of COCs in sediments at the Site under existing conditions. Exposure to contaminants at levels that would result in acute effects are not anticipated, due to construction BMPs and dilution. Except for fish captured or injured or killed during work area isolation, pile driving and dredging, individual fish whose condition or behavior is impaired by the effects of a project completed under this opinion are likely to suffer primarily from ephemeral or short-term sublethal effects during construction. No substantial negative long-term effects on population abundance or productivity are expected. Growth and development of juvenile salmonids is expected to improve after site remediation, due to improved water quality and cover, less disease and predator-induced mortality, and improved forage and passage conditions.

Adult and subadult green sturgeon may be affected by dispersal of contaminants. The dispersal in suspended sediments from dredging and other remedial activities in the Lower Willamette River have the potential for downriver transport of fine-grained sediments and associated contamination to the mouth of the Lower Columbia River. If contaminants settle out of the water column and into the sediment, green sturgeon may ingest contaminants as they feed in the estuary. Over time, it is expected that the proposed action will reduce COC loading to downriver areas.

Impacts to eulachon at each life stage are assumed to be similar to salmon and steelhead. Adult eulachon impacts are assumed to be similar to salmon and steelhead, although impacts of contaminants on adult eulachon reproductive behavior are undocumented. Eulachon can take up and store pollutants from their spawning rivers, even though they do not feed in fresh water and remain there only a few weeks (NMFS 2017c), and eulachon avoid polluted waters when possible (Smith and Saalfeld 1955).

Little is known about specific effects of contaminants on sunflower sea stars or how stress from exposure to such chemicals affects susceptibility to sea star wasting syndrome. Laboratory challenge tests have exposed larval stages of various marine invertebrates to hydrocarbons, heavy metals, pesticides, and other contaminants commonly found in stormwater runoff. Documented impacts range from developmental abnormalities to behavioral augmentation, and mortality is common at concentrations as low as several parts per million (Hudspith et al. 2017, de Almeida Rodrigues et. al 2022). For juvenile and adult marine invertebrates, including sea stars and other echinoderms, a variety of sublethal behavioral and physiological effects from these toxic contaminants have been documented, but mortality is also possible. Absent species-specific data for the sunflower sea star, ecologically and physiologically similar species can be used as proxies to state that stormwater runoff resulting from the proposed action may harm, injure, or kill sunflower sea stars, with the greatest potential for adverse effects occurring during the larval life history stage.

No detrimental long-term effects to salmonids, green sturgeon, eulachon, or sunflower sea stars are expected for the Lower Columbia River portion of the action area. Contaminant loading is expected to decrease over time due to the proposed action, and compensatory mitigation from both temporary and permanent negative impacts are expected to have a positive long-term effect.

We expect compensatory mitigation implemented under the Portland Harbor Cleanup proposed action to be in place within one to several years after project approval, and expect that the offsetting effects of the restoration would begin to occur as soon as one year after restoration project completion. This expected time delay in achieving a conservation offset is acceptable because significant evidence supports our assumption that ecosystem improvements in nearshore environments will occur rapidly once restoration is complete. For example, Lee et al. (2018) documented strong and positive biotic restoration response within one year of the removal of shoreline armoring.

Effects of Monitoring on Species

The primary effect of the proposed monitoring will be caused by capturing, handling, and releasing fish, which generally leads to stress and other sub-lethal effects.

The EPA is requiring pre-design and post-action monitoring that is expected to directly target ESA-listed fish use of Portland Harbor cleanup sites, but more typically, would target non-listed resident fish species, invertebrates, or simply involve collection of water, sediment, or vegetation samples and have the potential to incidentally capture or kill ESA-listed fish in the action area.

The following subsections describe the types of activities being proposed under environmental sampling. Each is described in terms broad enough to apply to all the individual projects that may be conducted under the proposed action. The activities would be carried out by trained professionals using established protocols. The effects of the activities are well documented and discussed in detail below. No researcher would receive a permit unless the activities incorporate NMFS' uniform, pre-established set of mitigation measures. They are incorporated (where relevant) into every authorization as part of the conditions to which a researcher must adhere.

Capture/handling

The primary effect of the proposed monitoring would be in the form of capturing and handling fish. Harassment caused by capturing, handling, and releasing fish often leads to stress and other sub-lethal effects that are difficult to assess in terms of their impact on individuals, populations, and species (Sharpe et al. 1998). Handling of fish may cause stress, injury, or death, which typically are due to overdoses of anesthetic, differences in water temperatures between the river and holding buckets, depleted dissolved oxygen in holding buckets, holding fish out of the water, and physical trauma. Excessive air exposure causes gill lamellae to collapse, ceasing aerobic respiration and causing hypoxia. High water temperature can contribute to high mortality following air exposure (Patterson et al. 2017). Loss of protective mucus is a common injury during capture and handling, increasing susceptibility to disease (Cook et al. 2018). Mucus contains antibacterial proteins, and its loss makes fish vulnerable to pathogens that may cause infections and latent mortality. Fish held at higher water temperatures have a higher risk of infection post-sampling (Patterson et al. 2017). Stress on salmonids increases rapidly from handling if the water temperature exceeds 18ºC or dissolved oxygen is below saturation. Exhaustion from excess physical activity can result in death through acidosis or latent mortality due to the inability to recover from exhaustion.

Fish that survive physiological imbalances caused during handling can lose equilibrium and have impaired swimming abilities, increasing their susceptibility to predation (Cook et al. 2017). Fish transferred to holding buckets can experience trauma if care is not taken in the transfer process, and fish can experience stress and injury from overcrowding in traps, nets, and buckets. Capture and handling stressors can combine to cause cumulative effects that greatly increase the likelihood of fish mortality. The permit conditions identified in Section 1.3 contain measures that mitigate factors that commonly lead to stress and trauma from handling, and thus minimize the harmful effects of capturing and handling fish. When these measures are followed, fish typically recover rapidly from handling.

Anesthetics are crucial for minimizing stress and immobilizing fish during handling, transport, blood sampling, PIT tagging, and tissue sampling. Commonly used fish anesthetics include Tricaine Methanesulfonate (MS-222), Clove oil, Benzocaine, and 2-Phyenoxyethanol. These are typically administered through immersion, where fish absorb the anesthetic through their gills. Anesthetics depress the central and peripheral nervous system, resulting in a state of sedation during which the fish is rendered unconscious, minimizing changes to biochemical stress indicators including plasma cortisol, glucose, and lactate (Martins et al. 2018). Stress responses in fish need to be minimized since they have negative physiological effects that can compromise growth, reproduction, and immunity (Souza et al. 2019). Immersion anesthetics typically have higher efficacy in warmer water temperatures and lower efficacy in water with low pH value (Neiffer & Stamper 2009, Priborsky & Velisek 2018). Higher doses are associated with quicker induction and longer recovery. Fish anesthetics can alter fish plasma biochemical indices, hematological profile, oxidative stress biomarkers, and antioxidant enzymes (Priborsky & Velisek 2018). When chemical anesthetics are first administered, fish can experience a phase of intense excitement and agitation as their inhibitory neurons become depressed before full anesthesia is achieved (Young et al. 2019, Souza et al. 2019). Exposure to high levels of anesthetics can thus induce stress (Young et al. 2019), and anesthetic overdoses can be fatal.

Tricaine Methanesulfonate (MS-222) is a widely used anesthetic in fish research, and the only fish anesthetic approved by the FDA for use in fish that people may consume —this includes ESA-listed fish that may be harvested. MS-222 requires personal protective equipment during handling and must be mixed with a buffering agent since it reduces water pH (Neiffer & Stamper 2009, Martins et al. 2018). During surgery an anesthetic maintenance dose is required to maintain stage 4 anesthesia (Carter et al. 2010). MS-222 can cause several side effects, including compromising a fish's antioxidant defenses, increasing cortisol (which reduces oxygen uptake), and reducing blood flow through the gills (Teles et al. 2019). Long-term effects of MS-222 exposure are not adequately known, and ease of accidental overdose from MS-222 is a concern (Carter et al. 2010).

Seines, traps, and hand or dip net methods are generally used to obtain information on fish distribution and abundance, habitat use, life history, and outmigration timing, and are often used to capture fish for further data collection procedures such as tagging, sampling, or gastric lavage. Beach seines and small traps (such as minnow traps or similar) are used to collect juvenile fish in shallow-water habitats. Boat seines (such as purse seines) and large traps (such as fyke traps, or similar) are used to collect or observe adults. Nets can injure fish by removing protective mucus and tearing gills (Patterson et al. 2017). Wearing gloves during handling and using soft rubber or knotless nets minimizes damage to fish gills, scales, and mucus. Handling should generally be conducted with soft, smooth, and pre-wetted gear. Based on years of sampling at hundreds of locations under hundreds of scientific research authorizations, we would expect the mortality rates for fish captured by seines, traps, or hand/dip nets to be three percent or less.

Electrofishing

Electrofishing is a process by which an electrical current is passed through water containing fish to stun them, which makes them easy to capture. High voltage current is passed between an anode and a cathode, which induces muscular convulsions (galvanotaxis) in fish when they encounter a high enough voltage gradient between the electrodes. Electrofishing can have several short-term effects, including stress, fatigue, reduced feeding, and susceptibility to predation (NMFS 2000). Electrofishing can also cause physical injuries, such as internal hemorrhaging and spinal injuries, which are caused by galvanotaxis. Mortality from electrofishing is typically due to respiratory failure or asphyxiation (Snyder 2003). The extent to which sampled fish are affected depends on the electrofishing waveform, pulse frequency, fish age and size, number of exposures, and operator skill (Panek & Densmore 2011, Simpson et al. 2016, Chiaramonte 2020, Pottier & Marchand 2020). Research indicates that using continuous direct current (DC) or low-frequency (30 Hz) pulsed DC waveforms (PDC) produce lower spinal injury rates, particularly for salmonids (Holliman et al. 2010, Pottier & Marchand 2020, Clancy et al. 2021). Higher frequencies generally result in better catch efficiency albeit with higher rates of injury (Chiaramonte et al. 2020).

Adult salmonids are particularly susceptible to spinal injuries, as longer fish (> 300mm) are subjected to strong voltage gradients by the electrofishing anode (Pottier & Marchand 2020). Spinal injuries to salmonids become increasingly detectable over time and are often not immediately apparent (Holliman et al. 2010). To avoid causing such injuries, we do not allow electrofishing to be used as a method for capturing adult salmonids. Though electrofishing crews do sometimes inadvertently encounter adults during their work, they must immediately turn off their equipment and allow the fish to swim away. Smaller juvenile fish are subjected to lesser voltage gradients, but there is conflicting evidence about whether this results in lower rates of injury (Snyder 2003). Spawning female salmonids are also vulnerable, since electrofishing can reduce survival rates for eggs spawned from previously electroshocked females (Cho et al. 2002, Huysman et al. 2018). Salmon in early developmental stages, including embryos and alevin, are another vulnerable group for whom electrofishing should be avoided (Simpson et al. 2016). Electrofishing can also harm non-target species, particularly during multiple pass depletion surveys, during which non-target fish can be exposed to multiple electroshocks (Panek & Densmore 2011). Injuries for target fish and non-target bycatch alike increase with multiple exposures (Panek & Densmore 2013).

When appropriate electrofishing protocols and equipment settings are used, shocked fish normally revive quickly. When done carefully, electrofishing of individual fish has been shown not to affect wild salmonid abundance (Clancy et al. 2021), and individual long-term survival is not usually compromised (Snyder 2003). However, electroshock exposure may stunt individual growth, resulting in abnormally low weight and small size (Thompson et al. 1997, Dwyer et al. 2001). The latent, sublethal, and population-level impacts of electrofishing are not well understood and further research is recommended. Permit conditions would require that all researchers follow NMFS' electrofishing guidelines (NMFS 2000). The guidelines require that field crews:

- Use electrofishing only when other survey methods are not feasible.
- Be trained by qualified personnel in equipment handling, settings, maintenance to ensure proper operating condition, and safety.
- Conduct visual searches prior to electrofishing on each date and avoid electrofishing near adults or redds. If an adult or a redd is detected, researchers must stop electrofishing at the research site and conduct careful reconnaissance surveys prior to electrofishing at additional sites.
- Test water conductivity and keep voltage, pulse width, and rate at minimal effective levels. Use only DC waveforms.
- Work in teams of two or more technicians to increase both the number of fish seen at one time and the ability to identify larger fish without having to net them. Working in teams allows netter(s) to remove fish quickly from the electrical field and to net fish farther from the anode, where the risk of injury is lower.
- Observe fish for signs of stress and adjust electrofishing equipment to minimize stress.
- Provide immediate and adequate care to any fish that does not revive immediately upon removal from the electrical current.

The preceding discussion focused on the effects of backpack electrofishing and the ways those effects would be mitigated. In larger streams and rivers, electrofishing units are sometimes mounted on boats or rafts. These units often use more current than backpack electrofishing equipment because they need to cover larger and deeper areas. The environmental conditions in larger, more turbid streams can limit researchers' ability to minimize impacts on fish. As a result, boat electrofishing can have a greater impact on fish.

Gastric Lavage

Knowledge of the food and feeding habits of fish are important in the study of aquatic ecosystems. However, in the past, food habit studies required researchers to kill fish for stomach removal and examination. Consequently, several methods have been developed to remove stomach contents without injuring the fish. Most techniques use a rigid or semi-rigid tube to inject water into the stomach to flush out the contents.

Few assessments have been conducted regarding the mortality rates associated with nonlethal methods of examining fish stomach contents (Kamler and Pope 2001). However, Strange and Kennedy (1981) assessed the survival of salmonids subjected to stomach flushing and found no difference between stomach-flushed fish and control fish that were held for three to five days. In addition, when Light et al. (1983) flushed the stomachs of electrofished and anesthetized brook trout, survival was 100 percent for the entire observation period. In contrast, Meehan and Miller (1978) determined the survival rate of electrofished, anesthetized, and stomach-flushed wild and hatchery coho salmon over a 30-day period to be 87 percent and 84 percent, respectively.

Hook and Line/Angling

Fish caught with hook and line and released alive may still die due to injuries and stress they experience during capture and handling. Angling-related mortality rates vary depending on the type of hook (barbed vs. barbless), the type of bait (natural vs artificial), water temperature, anatomical hooking location, species, and the care with which fish are handled and released (level of air exposure and length of time for hook removal).

The available information assessing hook and release mortality of adult steelhead suggests that hook and release mortality with barbless hooks and artificial bait is low. Nelson et al. (2005) reported an average mortality of 3.6 percent for adult steelhead that were captured using barbless hooks and radio tagged in the Chilliwack River, BC. The authors also note that there was likely some tag loss and the actual mortality might be lower. Hooton (1987) found catch-and-release mortality of adult winter steelhead to average 3.4 percent (127 mortalities of 3,715 steelhead caught) when using barbed and barbless hooks, bait, and artificial lures. Among 336 steelhead captured on various combinations of popular terminal gear in the Keogh River, the mortality of the combined sample was 5.1 percent. Natural bait had slightly higher mortality (5.6 percent) than did artificial lures (3.8 percent), and barbed hooks (7.3 percent) had higher mortality than barbless hooks (2.9 percent). Hooton (1987) concluded that catching and releasing adult steelhead was an effective mechanism for maintaining angling opportunity without negatively affecting stock recruitment. Reingold (1975) showed that adult steelhead hooked, played to exhaustion, and then released returned to their target spawning stream at the same rate as steelhead not hooked and played to exhaustion. Pettit (1977) found that egg viability of hatchery steelhead was not negatively affected by the catch and release of pre-spawning adult female steelhead. Bruesewitz (1995) found, on average, fewer than 13 percent of harvested summer and winter steelhead in Washington streams were hooked in critical areas (tongue, esophagus, gills, eye). The highest percentage (17.8 percent) of critical-area hookings occurred when using bait and treble hooks in winter steelhead fisheries.

The referenced studies were conducted when water temperatures were relatively cool, and primarily involve winter-run steelhead. Catch-and-release mortality of steelhead is likely to be higher if the activity occurs during warm water conditions. In a study conducted on steelhead catch-and-release mortality in a California river, Taylor and Barnhart (1999) reported over 80 percent of the observed mortalities occurred at stream temperatures greater than 21 degrees C. Catch-and-release mortality during periods of elevated water temperature are likely to result in post-release mortality rates greater than reported by Nelson et al. (2005) or Hooton (1987) because of warmer water and the fact that summer fish have an extended freshwater residence that makes them more likely to be caught. As a result, NOAA Fisheries expects steelhead hook and release mortality to be in the lower range discussed above.

Juvenile steelhead occupy many waters that are also occupied by resident trout species and it is not possible to visually separate juvenile steelhead from similarly-sized, stream-resident rainbow trout. Because juvenile steelhead and stream-resident rainbow trout are the same species, are similar in size, and have the same food habits and habitat preferences, it is reasonable to assume that catch-and-release mortality studies on stream-resident trout are similar for juvenile steelhead. Where angling for trout is permitted, catch-and-release fishing with prohibition of use of bait reduces juvenile steelhead mortality more than any other angling regulatory change. Artificial lures or flies tend to superficially hook fish, allowing expedited hook removal with minimal opportunity for damage to vital organs or tissue (Muoneke and Childress 1994). Many studies have shown trout mortality to be higher when using bait than when angling with artificial lures and/or flies (Taylor and White 1992, Schill and Scarpella 1995, Muoneke and Childress 1994, Mongillo 1984, Wydoski 1977, Schisler and Bergersen 1996). Wydoski (1977) showed the average mortality of trout, when using bait, to be more than four times greater than the mortality associated with using artificial lures and flies. Taylor and White (1992) showed the average mortality of trout to be 31.4 percent when using bait versus 4.9 and 3.8 percent for lures and flies, respectively. Schisler and Bergersen (1996) reported the average mortality of trout caught on passively fished bait to be higher (32 percent) than mortality from actively fished bait (21 percent). Mortality of fish caught on artificial flies was only 3.9 percent. In the compendium of studies reviewed by Mongillo (1984), mortality of trout caught and released using artificial lures and single barbless hooks was often reported at less than 2 percent.

Most studies have found a notable difference in the mortality of fish associated with using barbed versus barbless hooks (Huhn and Arlinghaus 2011, Bartholomew and Bohnsack 2005, Taylor and White 1992, Mongillo 1984, Wydoski 1977). Researchers have generally concluded that barbless hooks result in less tissue damage, are easier to remove, and because they are easier to remove, the handling time is shorter. In summary, catch-and-release mortality of steelhead is generally lowest when researchers are restricted to the use of artificial flies and lures. As a result, all steelhead sampling via angling must be carried out using barbless artificial flies and lures.

Only a few reports are available that provide empirical evidence showing what the catch-and-release mortality is for Chinook salmon in freshwater. The ODFW has conducted studies of hooking mortality incidental to the recreational fishery for Chinook salmon in the Willamette River. A study of the recreational fishery estimates a per-capture hook-and-release mortality for wild spring Chinook salmon in Willamette River fisheries of 8.6 percent (Schroeder et al. 2000), which is similar to a mortality of 7.6 percent reported by Bendock and Alexandersdottir (1993) in the Kenai River, Alaska.

A second study on hooking mortality in the Willamette River, Oregon, involved a carefully controlled experimental fishery, and mortality was estimated at 12.2 percent (Lindsay et al. 2004). In hooking mortality studies, hooking location, gear type, and unhook time is important in determining the mortality of released fish. Fish hooked in the jaw or tongue suffered lower mortality (2.3 and 17.8 percent in Lindsay et al. (2004)) compared to fish hooked in the gills or esophagus (81.6 and 67.3 percent). Numerous studies have reported that deep hooking is more likely to result from using bait (e.g., eggs, prawns, or ghost shrimp) than lures (Lindsay et al. 2004). One theory is that bait tends to be passively fished and the fish is more likely to swallow bait than a lure. Passive angling techniques (e.g., drift fishing) are often associated with higher hooking mortality rates for salmon while active angling techniques (e.g., trolling) are often associated with lower hooking mortality rates (Cox-Rogers et al. 1999).

Catch-and-release fishing does not seem to affect migration. Lindsay et al. (2004) noted that "hooked fish were recaptured at various sites at about the same frequency as control fish." Bendock and Alexandersdottir (1993) found that most of their tagged fish later turned up on the spawning grounds. Cowen et al. (2007) found little evidence of an adverse effect on spawning success for Chinook salmon.

Not all of the fish that are hooked are subsequently landed. We were unable to find any studies that measured the effect of hooking and losing a fish. However, it is reasonable to assume that nonlanded morality would be negligible, as fish lost off the hook are unlikely to be deeply hooked and would have little or no wound and bleeding (Cowen et al. 2007).

Based on the available data, the *U.S. v. Oregon* Technical Advisory Committee has adopted a 10 percent rate in order to make conservative estimates of incidental mortality in fisheries (TAC 2008). Nonetheless, given the fact that no ESA section 10 permit or 4(d) authorization may "operate to the disadvantage of the species," we allow no more than a three percent mortality rate for any listed species collected via angling, and all such activities must employ barbless artificial lures and flies.

Observation
For some parts of the proposed studies, listed fish would be observed but not captured (e.g., by snorkel surveys or from the banks). Observation without handling is the least disruptive method for determining a species' presence/absence and estimating their relative numbers. Its effects are also generally the shortest-lived and least harmful of the research activities discussed in this section because a cautious observer can effectively obtain data while only slightly disrupting the fishes' behavior. Fry and juveniles frightened by the turbulence and sound created by observers are likely to seek temporary refuge in deeper water or behind or under rocks or vegetation. In extreme cases, some individuals may leave a particular pool or habitat type and then return when observers leave the area. At times, the research involves observing adult fish, which are more sensitive to disturbance. During some of the research activities discussed below, redds may be visually inspected, but per NMFS' pre-established mitigation measures (included in state fisheries agency submittals), would not be walked on. Only in the rarest cases would any take be associated with these observation activities, which would be in the form of harassment (see section 2.9). No injuries and no deaths would be expected to occur—particularly in cases where the researchers observe from the stream banks rather than in the water. Because these effects are so small, there is little a researcher can do to mitigate them except to avoid disturbing sediments, gravels, and, to the extent possible, the fish themselves, and allow any disturbed fish the time they need to reach cover.

Screw trapping
Smolt, rotary screw (and other out-migration) traps are generally used to obtain information on natural population abundance and productivity. On average, they achieve a sample efficiency of four to 20 percent of the emigrating population from a river or stream, depending on river size. However, under some conditions, traps may achieve a higher efficiency in a relatively short period of time. Based on years of sampling at hundreds of locations under hundreds of scientific research authorizations, we would expect the mortality rates for fish captured at rotary screw-type traps to be one percent or less.

The trapping, capturing, or collecting and handling of juvenile fish using traps is likely to cause some stress on listed fish. However, fish typically recover rapidly from handling procedures. The primary factors that contribute to stress and mortality from handling are excessive doses of anesthetic, differences in water temperature, dissolved oxygen conditions, the amount of time that fish are held out of water, and physical trauma. Stress on salmonids increases rapidly from handling if the water temperature exceeds 64.4 degrees F (18 degrees C) or if dissolved oxygen is below saturation. Additionally, stress can occur if there are more than a few degrees difference in water temperature between the stream/river and the holding tank.

The potential for unexpected injuries or mortalities among listed fish is reduced in a number of ways. These can be found in the individual study protocols and in the permit conditions stated earlier. We assume minimum permit conditions which include that screw traps are checked at least daily and usually fish are handled in the morning. This ensures that the water temperature is at its daily minimum when fish are handled. Also, fish may not be handled if the water temperature exceeds 69.8 degrees Fahrenheit (21 degrees C). Great care must be taken when transferring fish from the trap to holding areas. The most benign methods available are often used, which means using sanctuary nets when transferring fish to holding containers to avoid potential injuries. The investigators' hands must be wet before and during fish handling. Appropriate anesthetics must be used to calm fish subjected to collection of biological data. Captured fish must be allowed to fully recover before being released back into the stream and will be released only in slow water areas. And often, several other stringent criteria are applied on a case-by-case basis: safety protocols vary by river velocity and trap placement, the number of times the traps are checked varies by water and air temperatures, the number of people working at a given site varies by the number of outmigrants expected, etc. These protocols, and more, are used to ensure the mortality rates stay at one percent or lower.

Tangle Netting

Tangle nets are similar to gillnets, having a top net with floats and a bottom net with weights, but tangle nets have smaller mesh sizes than gill nets. Tangle nets are designed to capture fish by the snout or jaw, rather than the gills. Researchers must select the mesh size carefully depending on their target species, since a tangle net may act as a gill net for fish that are smaller than the target size.

Tangle nets can efficiently capture salmonids in large rivers and estuaries, and have been used successfully for the Lower Columbia River spring Chinook salmon commercial fishery (Ashbrook et al. 2005, Vander Haegen et al. 2004). However, fish may be injured or die if they become physiologically exhausted in the net or if they sustain injuries such as abrasion or fin damage. Entanglement in nets can damage the protective slime layer, making fish more susceptible to infections. These injuries can result in immediate or delayed mortality. Vander Haegen et al. (2005) reported that spring Chinook salmon had lower delayed mortality rates when captured in tangle nets (92 percent survival) versus gill nets (50 percent survival) relative to a control group. Vander Haegen et al. (2005) emphasized that, to minimize both immediate and delayed mortality, researchers must employ best practices including using short nets with short soak times, and removing fish from the net carefully and promptly after capture. As with other types of capture, fish stress increases rapidly if the water temperature exceeds 18 ºC or dissolved oxygen is below saturation.

Tagging/Marking

Techniques such as Passive Integrated Transponder (PIT) tagging, coded wire tagging, fin-clipping, and the use of radio transmitters are common to many scientific research efforts using listed species. All sampling, handling, and tagging procedures have an inherent potential to stress, injure, or even kill the marked fish. This section discusses each of the marking processes and its associated risks.

A PIT tag is an electronic device that relays signals to a radio receiver; it allows salmonids to be identified whenever they pass a location containing such a receiver (e.g., any of several dams) without researchers having to handle the fish again. The tag is inserted into the body cavity of the fish just in front of the pelvic girdle. The tagging procedure requires that the fish be captured and extensively handled; therefore, any researchers engaged in such activities will follow the conditions listed previously in this Opinion (as well as any permit-specific conditions) to ensure that the operations take place in the safest possible manner. In general, the tagging operations will take place where there is high-quality cold water, a carefully controlled environment for administering anesthesia, sanitary conditions, quality control checking, and a carefully regulated holding environment where the fish can be allowed to recover from the operation.

The PIT tags have very little effect on growth, mortality, or behavior. The few reported studies of PIT tags have shown no effect on growth or survival (Prentice et al. 1987, Jenkins and Smith 1990, Prentice et al. 1990). For example, in a study between the tailraces of Lower Granite and McNary Dams (225 km), Hockersmith et al. (2000) concluded that the performance of yearling Chinook salmon was not adversely affected by gastrically or surgically implanted sham radio tags or PIT-tags. Additional studies have shown that growth rates among PIT-tagged Snake River juvenile fall Chinook salmon in 1992 (Rondorf and Miller 1994) were similar to growth rates for salmon that were not tagged (Connor et al. 2001). Prentice and Park (1984) also found that PIT-tagging did not substantially affect survival in juvenile salmonids.

Coded wire tags (CWTs) are made of magnetized, stainless-steel wire. They bear distinctive notches that can be coded for such data as species, brood year, hatchery of origin, and so forth (Nielsen 1992). The tags are intended to remain within the animal indefinitely, consequently making them ideal for long-term, population-level assessments of Pacific Northwest salmon. The tag is injected into the nasal cartilage of a salmon and, therefore, causes little direct tissue damage (Bergman et al. 1968, Bordner et al. 1990). The conditions under which CWTs may be inserted are similar to those required for applying PIT-tags.

A major advantage to using CWTs is the fact that they have a negligible effect on the biological condition or response of tagged salmon; however, if the tag is placed too deeply in the snout of a fish, it may kill the fish, reduce its growth, or damage olfactory tissue (Fletcher et al. 1987, Peltz and Miller 1990). This latter effect can create problems for species like salmon because they use olfactory clues to guide their spawning migrations (Morrison and Zajac 1987).

For researchers to determine later (after the initial tagging) which fish possess CWTs, it is necessary to mark the fish externally—usually by clipping the adipose fin—when the CWT is implanted (see text below for information on fin clipping). One major disadvantage to recovering data from CWTs is that the fish must be killed for the tag to be removed. However, this is not a significant problem because researchers generally recover CWTs from salmon that have been taken during commercial and recreational harvest (and are, therefore, already dead).

Trawls

Trawls are cone-shaped, mesh nets that are towed, often, along benthic habitat (Hayes 1983, Hayes et al. 1996). Rectangular doors, attached to the towing cables, keep the mouth of the trawl open. Most trawls are towed behind a boat, but small trawls can be operated by hand. As fish enter the trawl, they tire and fall to the cod end of the trawl. Mortality and injury rates associated with trawls can be high, particularly for small or fragile fish. Fish can be crushed by debris or other fish caught in the net. However, all of the trawling considered in this Opinion is midwater trawling, which may be less likely to capture heavy debris loads than benthic or demersal trawl sampling. Depending on mesh size, some small fish are able to escape the trawl through the netting. However, not all fish that escape the trawl are uninjured, as fish may be damaged while passing through the netting. Short-duration trawl hauls (5 to 10 minutes maximum) may reduce injuries (Hayes 1983, Stickney 1983, Hayes et al. 1996).

2.5.2 Effects on Critical Habitat

Completion of each project is expected to have the following set of effects on the PBFs or habitat qualities essential to the conservation of each species, these effects will vary somewhat in severity between projects because of differences in the scope of construction at each, and in the current condition of PBFs and the factors responsible for those conditions. This assumption is based on the fact that all of the projects are based on the same set of underlying construction actions and the PBFs and conservation needs identified for each species are also essentially the same. In general, ephemeral effects are expected to last for hours or days, short-term effects are expected to last for weeks, and long-term effects are expected to last for months, years or decades. Actions with more significant construction component are likely to have direct adverse effects to a larger area, and to take a longer time to recover, than actions based in restoration of a single habitat element. However, they are also likely to have correspondingly greater conservation benefits.

Effects on ESA-Listed Salmon and Steelhead Critical Habitat.

Essential habitat for listed salmonids includes summer and winter rearing areas, juvenile migration corridors, areas for growth and development to adulthood, and adult migration corridors, and spawning areas. Juvenile summer and winter rearing areas and spawning areas are often in small headwater streams and side channels, while juvenile migration corridors and adult migration corridors include tributaries, mainstem river reaches and estuarine areas. Growth and development to adulthood occurs primarily in near- and off-shore marine water, although final maturation takes place in freshwater tributaries when the adults return to spawn. Of these, the action area has been designated as essential for spawning and rearing, juvenile migration, and adult migration. The essential features of critical habitat for listed salmonids are substrate, water quality, water quantity, water temperature, water velocity, cover/shelter, food, riparian vegetation, space, access and safe passage conditions.

1. Freshwater spawning sites
a. Water quantity – Ephemeral reduction due to short-term construction (draining, diverting or withdrawal), reduced riparian soil permeability, and increased riparian runoff; slight longer-term increase based on improved riparian function and floodplain connectivity following mitigation efforts.
b. Water quality – Short-term increase in turbidity, resuspension of chemical contaminants, decreased dissolved oxygen. Increased stormwater run-off at the transload facilities.
c. Substrate – Short-term reduction due to increased compaction and sedimentation. Long-term improvement in substrate through the placement of sand and gravels.
2. <u>Freshwater rearing sites</u>
a. Water quantity – as above.
b. Floodplain connectivity – Long-term increase following the implementation of compensatory mitigation and restoration.
c. Water quality – as above.
d. Forage – Short-term loss of forage from dredging, capping, in situ treatment and piling removal and installation; Long-term loss of forage from the placement of armored engineered

caps; Long-term increase in storage as compensatory mitigation projects enhance off-channel complexity and riparian habitats.
e. Natural cover – Short-term decrease due to riparian and channel disturbance; Long -term increase due to replaced riparian function from compensatory mitigation projects and the removal of shoreline armor.
3. Freshwater migration corridors
a. Free passage – Short-term decrease due to decreased water quality and in-water construction activities; long-term decrease due to increased predator habitat; Long-term decrease with the construction of the transload facilities; Long-term increase as artificial obstructions are removed during clean-up.
b. Water quantity – as above.
c. Water quality – as above.
d. Forage – as above.
e. Natural cover – as above.
4. Estuarine areas
a. Free passage – as above.
b. Water quality – as above.
c. Water quantity – as above.
d. Natural cover – as above.
e. Juvenile forage – as above.
f. Adult forage – Short-term loss of forage from dredging, capping, in situ treatment and piling removal and installation; Long-term loss of forage from the placement of armored engineered caps; Long-term increase in storage as compensatory mitigation projects enhance off-channel complexity and riparian habitats.

Effects on Green Sturgeon Critical Habitat
The relevant PBFs for green sturgeon include food resources, water flow, water quality, depth, and migratory corridors, and sediment quality to support migration, aggregation and holding, and feeding by subadult and adult green sturgeon, for both freshwater riverine and estuarine habitats. Because the effects are the same, both habitats are summarized together. There is no effect on food, water flow, depth, or migratory corridor PBFs. Water and sediment quality may be impacted due to the dispersal of contaminants in suspended sediments from dredging and other remedial activities in the Lower Willamette River, which have the potential for downriver transport of fine-grained sediments and associated contamination downstream to the mouth of the Lower Columbia River. Over time, it is expected that the proposed action will reduce COC loading to downriver areas.

Effects on Eulachon Critical Habitat
The relevant eulachon PBFs are: (1) freshwater spawning and incubation sites and (2) freshwater and estuarine migration corridors, both with water flow, quality, and temperature conditions to support these life stages. Because the effects are the same, PBFs for both life stages are summarized together, with the exception of prey for freshwater and estuarine migration corridors. There is no effect on water flow, temperature conditions, or prey PBFs. The dispersal of contaminants in suspended sediments from dredging and other remedial activities in the Lower Willamette River have the potential to affect the water quality PBF, since downriver transport of fine-grained sediments and associated contamination downstream to the mouth of

the Lower Columbia River may occur. Over time, the proposed action is expected to reduce COC loading to downriver areas.

Effects of Monitoring on Critical Habitat PBFs

In general, the post-action biological sampling activities would be surveying habitat characteristics, visually observing fish, plant, and invertebrate presence, collecting benthic or epibenthic invertebrates, collecting water, sediment, or vegetation samples for chemical analyses, capturing fish with angling equipment, traps, and nets of various types, and collecting fish for contaminant tissue analyses. These techniques are minimally intrusive in terms of their effect on habitat because they would involve minimal disturbance of streambeds or adjacent riparian zones. Some collection activities may involve collecting sediment samples or conducting trawls in estuarine environments, temporarily disturbing substrate, displacing benthic invertebrate prey, and increasing turbidity just above the water surface. However, such actions affect small spatial areas of habitat and are brief in duration, so these effects are expected to be ephemeral and attenuate rapidly. Therefore, none of the monitoring activities analyzed in this Opinion will measurably affect any habitat PBF function or value described earlier.

2.6. Cumulative Effects

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

Some continuing non-federal activities are reasonably certain to contribute to climate effects within the action area. However, it is difficult, if not impossible, to distinguish between the action area's future environmental conditions caused by global climate change that are properly part of the environmental baseline *vs.* cumulative effects. Therefore, all relevant future climate-related environmental conditions in the action area are described in the environmental baseline (Section 3.4).

The contribution of non-federal activities to the current condition of ESA-listed species and designated critical habitats within the program-level action area was described in the Status of the Species and Critical Habitats and Environmental Baseline sections, above. Agriculture, hydropower facilities, timber harvest, fishing, mining and other resource-based industries have caused many long-lasting environmental changes that harmed ESA-listed species and their critical habitats in the action area. Those include basin-wide loss or degradation of stream channel morphology, spawning substrates, instream roughness and cover, estuarine rearing habitats, wetlands, floodplains, riparian areas, water quality (e.g., temperature, sediment, dissolved oxygen, contaminants), fish passage, and habitat refugia. Those changes reduced the ability of populations of ESA-listed species to sustain themselves in the natural environment by altering or interfering with their behavior in ways that reduce their survival throughout their life cycle. The environmental changes also reduced the quality and function of critical habitat PBFs necessary for successful spawning, production of offspring, and migratory access for adult fish to swim upstream to reach spawning areas and for juvenile fish to proceed downstream and reach the ocean. Without those features, the species cannot successfully spawn and produce offspring.

Many of the activities that affect the action area (described in Section 3.3) are ongoing and will continue into the future. However, over time, the level of extraction of some natural resources and the associated habitat degradation in Oregon has declined, and industry standards and regulatory requirements have improved. For instance, large-scale placer mining for gold (NRC 1995, Lichatowich 1999) has been replaced by smaller recreational mining operations. Timber harvest in Oregon has decreased from roughly 8.5 billion board feet in the 1980s to an average of 3.8 billion board feet between 2005 to 2019 (most recent data available).[1] Although the Oregon Forest Practices Act (FPA) and associated forest practice rules generally have become more protective of riparian and aquatic habitats over time, significant concerns remain over their ability to adequately protect water quality and salmon habitat (Everest and Reeves 2007, IMST 1999). On October 26, 2022, administrative changes to the FPA, including development of a habitat conservation plan for aquatic species, were approved with requirements becoming effective in 2022, 2023, and 2024 (FPA 2022).

While widespread degradation of aquatic habitat associated with intense natural resource extraction is no longer common, ongoing and future land management actions are likely to continue to have a depressive effect on aquatic habitat quality in the action area. As a result, recovery of aquatic habitat is likely to be slow in most areas and cumulative effects are likely to have a neutral to negative impact on population abundance trends and the quality of critical habitat PBFs. However, the adoption of more environmentally acceptable practices and standards may gradually reduce some negative environmental impacts over time, and interest in restoration activities has increased as environmental awareness rises among the public. Implementation of plans, initiatives, and specific restoration projects are often subject to political, legislative, and fiscal challenges that increase the uncertainty of their success.

The action area is in the Portland metropolitan area and has a high population density. The past effect of development and general resource demands associated with the settlement of local and regional population centers is expressed as changes to physical habitat and loadings of pollutants in the Willamette River, as described above. The collective effects of these activities tend to be expressed most strongly in lower river systems where the consequences of numerous upstream land management actions aggregate to influence natural habitat processes and water quality.

The human population in the Portland area is likely to continue to grow in the foreseeable future (Metro 2016). Recreational and commercial use of the waters within the action area are also likely to increase as the human population grows. Areas that are gaining population around the City of Portland and parts of the Willamette Valley are likely to experience greater resource demands and, therefore, more adverse environmental effects. Oregon's land use laws and progressive policies related to long-range planning will help to limit those impacts by ensuring that concern for a healthy economy that generates jobs and business opportunities is balanced by concern for the protection of farms, forests, rivers, streams and natural areas (Metro 2000, Metro 2008, Metro 2011). In addition to careful land use planning to minimize adverse environmental

[1] Data available at: https://data.oregon.gov/Natural-Resources/Timber-Harvest-Data-1962-2019/c3sg-dt24 (accessed Dec. 2022)

impacts, larger population centers may partly offset the adverse effects of their growing resource demands with more river restoration projects designed to provide ecosystem-based cultural amenities. Thus, it is likely that trends in habitat and water quality in the action area will continue, but with changes as described below.

To counteract past trends in pollution of the LWR, state, tribal, local or private parties, including groups such as the Portland Harbor responsible parties, together with non-federal members of the Portland Harbor Natural Resource Trustee Council acting in their own capacity, are reasonably certain to continue taking aggressive actions to reduce toxic pollution and runoff to the Willamette River from all sources (EPA 2011, EPA 2017). Upland remediation activities are often unlikely to have a federal nexus for NMFS and thus will not be the subject of a section 7 consultation for NMFS species. However, these actions will likely lead to a significant reduction in the volume of some pollutants delivered to the LWR (EPA 2009, EPA 2011). In 2012 and 2017, the Oregon DEQ set more restrictive regulations for stormwater, requiring monitoring of most Portland Harbor COCs, location-specific benchmarks, and contaminant reductions for discharges into Portland Harbor and the Columbia Slough. Permit-regulated stormwater source controls cover approximately 70 percent of the developed land area draining to Portland Harbor (ODEQ 2020). In 2020, the DEQ reported reductions in contaminants between 2010 and 2017: a nearly 78 percent reduction of PCBs, 63 percent reduction of PAHs, 11 percent reduction of BEHPs, and 9 percent reduction in zinc.

In summary, resource-based activities such as timber harvest, agriculture, mining, shipping, and energy development are likely to continue to influence the quality of freshwater and estuarine habitat in the action area. The intensity of this influence is difficult to predict and is dependent on many social and economic factors. However, the adoption of industry-wide standards to reduce environmental impacts and the shift away from resource extraction to a mixed manufacturing and technology-based economy should result in a gradual decrease in influence over time. In contrast, the population of Oregon is expected to increase in the next several decades with a corresponding increase in natural resource consumption. Additional residential and commercial development and a general increase in human activities are expected to cause localized freshwater and estuarine habitat degradation. Interest in restoration activities is also increasing, as is environmental awareness among the public. This will likely lead to localized improvements to freshwater and estuarine habitat. When these influences are considered collectively, we expect trends in habitat quality to remain flat or improve gradually over time. This will, at best, positively influence population abundance and productivity for the species affected by this consultation. In a worst-case scenario, we expect cumulative effects would have a relatively neutral effect on population abundance trends. Similarly, we expect the quality and function of critical habitat PBFs or physical and biological features to express a slightly positive to neutral trend over time as a result of the cumulative effects.

2.7. Integration and Synthesis

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

Remediation of Portland Harbor will include dredging, capping, piling removal and installation, construction of transload facilities, in-situ treatment, ex-situ treatment, dewatering, and wastewater treatment, disposal, and transportation, or a combination of these activities. The a action agency plans to permit these activities, while overlaying a set of PDCs to minimize the environmental effects of those activities. The EPA will constrain those activities to in-water work windows to limit exposure of listed species to their adverse effects, causing water column changes in the Willamette River. By applying the appropriate PDCs prescribed in the program, most water quality changes will be ephemeral (instantaneous to hours) or short term (days to months).

Long-term consequences to benthic habitat from these activities may include a reduction in forage over a small area due to sediment removal and cover layer placement and extend for years to decades, or for the life of the project. For piling installation or removal, hydroacoustic impacts from the use of the impact and vibratory hammer may occur, as well as a lack of access to shallow-water habitat; however, removal of the possibly creosote-treated pilings would improve the water quality conditions in the project area by removing these chronic sources of contaminants, which may offset the continued presence of the structure.

Habitat alterations from the program will cause displacement of a small number of adult and juvenile fish, as they avoid the pile driving operation (elevated underwater noise and turbidity), dredging operation (entrainment and elevated turbidity), plus a period in which fish have reduced prey as the benthic biological productivity is reduced, and then re-establishes, in the vicinity of the dredge prism. Because these effects are relatively brief or small in scale, and only a few individual fish are likely to be exposed to them, an even smaller number of individuals are likely to be killed or injured.

The programmatic nature of the action relies on application of the proposed PDCs to minimize the adverse effects for which they are intended. By requiring the PDCs to fall within a limited and predictable level of impact, combined with the fact that the programmatic actions are remediating pollution, and that enduring effects will be offset through compensatory mitigation, the overall effects of the proposed action on ESA-listed species will be beneficial. Each remedial site will be carefully designed and constrained by the PDCs such that impacts of in-water construction (dredging and excavation, capping and treatment, piling removal and placement, riverbank construction) and transloading projects will cause only localized and short-term exacerbation of factors limiting the viability of the listed species. Longer-term impacts may result from some remedial projects, if they include capping (thereby limiting exposure to contaminants but also altering benthic habitat) or riverbank construction and stabilization (shading from structures or altering the shore with riprap), or by the addition of actions to offset unavoidable impacts when those standards cannot be achieved onsite. The NMFS expects that the proposed program will improve conditions in the Portland Harbor in the long term.

Certain projects carried out under the proposed action are anticipated to cause long-term effects on critical habitat physical and biological features. For instance, the free passage element of critical habitat may be degraded at the project-site scale from construction or replacement of in- or over-water structures due to a slight increase in predation or a small increase in migration time, or the element of forage may be degraded for years or permanently from capping. Maintenance of caps or structures is also anticipated after the conclusion of the project, with impacts similar to or less than those incurred initially, therefore adding to the effects on critical habitat; so, while the effects are short-term, the project itself is setting up a system for impacting the area long-term. Remedial actions in the project area are anticipated to have a positive long-term effect, even if there are negative short-term impacts during construction of these conservation areas.

The baseline conditions in the action area are consistent with the status of critical habitat and limiting factors, in that water quality and habitat conditions are significantly influenced by a host of anthropogenic changes that degrade features that these species rely on for growth, maturation, fitness, and survival. As noted in Section 3.2, climate change is likely to affect all species considered in this Opinion and their habitat in the program action area. These effects are expected to be positive and negative, but are likely to result in a generally negative trend for stream flow and temperature.

The last element in the integration of effects includes a consideration of the cumulative effects anticipated in the action area. As described in Section 3.6, the cumulative effects of state and private actions that are reasonably certain to occur within the action area are likely to reflect continued population growth in the Portland metropolitan area. Efforts to improve aquatic habitat conditions throughout the program area may moderate any adverse cumulative effects, and add to any beneficial ones, so that the action area may be guided toward improved habitat conditions overall. Bearing this status in mind, we now add the effects of the proposed action to the baseline, to determine the impact on species and critical habitat.

2.7.1 Listed Species

Each species considered in this Opinion is threatened by extinction risk, with the exception of three species (UCR spring Chinook salmon, Snake River sockeye salmon, and SRKW), which are considered endangered. Each of the species is listed due to a combination of low abundance and productivity, reduced spatial structure, and decreased genetic diversity of their constituent independent populations.

Salmonids that migrate through the Lower Columbia River to the upper portions of the river and its tributaries face many of the same threats. Freshwater habitat degradation, risks from hydropower, and predation by marine mammals and birds are likely to impact the continued viability of these stocks. Though habitat conditions are still degraded due to past and present anthropogenic activities, significant habitat restoration actions have been implemented to improve habitat conditions and restore fish passage. Still, it generally takes one to five decades to demonstrate increases in viability. Climate change on both the marine and freshwater parts of the ESU's habitat will likely impact water temperature and flow, and is likely increasing suitable habitat for non-native species and posing a challenge for juvenile and adult migration types. These are part of the baseline effects that are likely to occur even if the project did not take place.

The effects of the project likely include a short-term increase in contaminants, and while there is little information on the effect of toxic-impaired waters on juvenile and adult survival, contaminants may cause direct mortality or affect feeding behaviors or susceptibility to predation or disease.

Even when we consider the current status of the threatened and endangered fish populations and degraded environmental baseline within the action area, the proposed action's effects are likely to be very small, and are likely to span across more than one population and more than one species. Because sediment and contaminants re-suspended by the program will diffuse as it transports downstream, no single population or ESU is expected to be uniquely exposed at a greater level. We cannot predict the number of individual fish that will be exposed because of high variability in species presence at any given time, nor will all exposed individuals experience adverse effects. We expect that some individuals will experience sublethal effects, such as temporary threshold shifts due to construction noise or turbidity spikes. The fitness of individual fish that rear or migrate in degraded conditions may already be poor when they reach the action area, which would likely make them more susceptible to detrimental effects when they encounter effects of the proposed action. We expect that this exposure and response could reduce fitness or survival among some individuals, resulting in a small reduction of returning adults from those populations, but at a level that is indiscernible among the returns based on overall ocean survival rates that are influenced by multiple factors. This reduction in abundance itself is not expected to be sufficient to affect the long-term abundance, productivity, genetic diversity, or spatial diversity of any affected populations of the ESA-listed species. By requiring the PDCs to fall within a limited and predictable level of impact, combined with the fact that the programmatic actions are remediating pollution, and that enduring effects will be offset through compensatory mitigation, the overall effects of the proposed action on ESA-listed species will be beneficial.

The remainder of the integration and synthesis for our jeopardy determination will focus on how the effects of the proposed actions, when added to environmental baseline and cumulative effects, affect the likelihood of both the survival and recovery of LCR Chinook salmon, UWR Chinook salmon, UCR spring-run Chinook, SR spring/summer-run Chinook salmon, SR fall-run Chinook salmon, CR chum salmon, LCR coho salmon, SR sockeye salmon, LCR steelhead, UWR steelhead, MCR steelhead, UCR steelhead, SRB steelhead, eulachon, and green sturgeon,

Salmonids. There are 14 populations that will be exposed to all of the effects of the program by migrating in the Willamette River. Only the Clackamas population of UWR spring-run Chinook is meeting recovery objectives for abundance, and two populations, the Clackamas populations of LCR coho and steelhead, are over 25 percent of the recovery objectives for abundance. However, the Clackamas population of LCR coho declined by 21 percent over the past five years, and the Clackamas population of LCR steelhead is unchanged from the previous review period. Almost all populations within Portland Harbor are well below 20 percent of the recovery objective for abundance, thus the influence of adverse effects from the program carries greater import. Because of the high life-history diversity and juvenile migration timing of Chinook salmon in the Willamette Basin (both UWR and the Clackamas population of LCR Chinook), the work window will not entirely avoid any population, as both steelhead and spring Chinook have long freshwater life history behaviors. LCR fall-run Chinook and LCR coho may have reduced potential for exposure because of the summer work window, but full avoidance is not expected. Most steelhead juveniles remain in freshwater for two years prior to emigration, making them less susceptible to project impacts that occur downstream of their rearing location, and more susceptible to climatic changes in temperature and precipitation. Climate change is expected to have a suite of effects on salmonids, including changes in temperature and flow regimes, altered prey, increased competition from non-native species, and shifts in riparian vegetation.

Effects in Portland Harbor will affect all populations of UWR Chinook (seven populations) and steelhead (four populations). They will also affect the Clackamas populations of LCR Chinook, LCR coho, LCR chum, and LCR steelhead. The effects within the action area are water quality reductions, including turbidity and transfer of fine sediment, suspended contaminants, and decreased dissolved oxygen, possible removal of natural cover, adverse consequences to substrate and forage, entrainment and fish salvage, construction noise, modified prey communities, and modified substrate and bathymetry.

In the Lower Columbia River, there are eight ESUs/DPSs of salmonids, with a total of 95 populations combined. CR chum salmon, SR sockeye salmon, UCR spring-run Chinook salmon, and UCR steelhead are at high risk of extinction. MCR steelhead and SR steelhead are at moderate risk of extinction, SR fall-run Chinook salmon is at a moderate-to-low risk of extinction, and SR spring/summer-run Chinook salmon are at a moderate-to-high risk of extinction.

Effects that reach the Columbia River and affect all the species are water quality reductions, including turbidity and transfer of fine sediment, suspended contaminants, and decreased dissolved oxygen. Individual fish from all component populations may be exposed to some of those effects for the duration of the proposed program; however, effects are expected to be temporary and difficult to distinguish from background contaminants due to dilution from the high volume of water in the Columbia River. Compensatory mitigation projects that take place outside of remediation areas may impact listed salmonids through temporary increased turbidity, construction noise, and loss of benthic foraging habitat, but would result in ecological benefits from improving habitat.

These identified effects are not expected to cause a biologically meaningful effect at the species scale because of the limits placed on remedial actions each year (likely approval on no more than three remedial actions occurring simultaneously; limits on dredged material transload exist under the proposed action) and the short duration of the anticipated effects. Because of this, there will likely be only a small number of fish affected at any one time, and thus will not cause meaningful effects at the population level, which in turn means they are unlikely to register at the species level. The effects themselves are limited or beneficial, and they occur in an affected area that represents a very small portion of habitat available to any one population. Therefore, the proposed action is not likely to appreciably reduce the likelihood of survival and recovery for LCR Chinook, LCR coho, LCR steelhead, UWR Chinook, UWR steelhead, UCR spring-run Chinook, UCR steelhead, SR spring/summer-run Chinook, SR fall-run Chinook. SR sockeye, CR chum, MCR steelhead and SRB steelhead, even when combined with a degraded environmental baseline, additional pressure from cumulative effects, and climate change.

Eulachon. The southern DPS of eulachon is listed as threatened. Eulachon are found in the Lower Columbia River portion of the action area and are impacted by water quality.

Contaminants, such as those resuspended due to the proposed action, are a moderate threat, and the high lipid content of eulachon suggests they may be susceptible to absorption of organic contaminants (NMFS 2017c). Although downstream transport of contaminants, altered flow and increased temperature from the program are expected, the program is expected to benefit eulachon in the long-term by removing a persistent source of contaminants, and requiring compensatory mitigation to offset adverse effects to ESA-listed species. Therefore, the proposed action is not likely to appreciably reduce the likelihood of survival and recovery of eulachon, even when combined with a degraded environmental baseline and additional pressure from cumulative effects, and climate change.

Green sturgeon. The southern DPS of green sturgeon is listed as threatened, and its status remains steady. Some threats, such as barriers to migration or bycatch in fisheries have been reduced, while climate change persists. Climate change could affect the health of subadult and non-spawning adult green sturgeon found in the action area due to poor water quality and prey shifts (NMFS 2021a). Though information is limited, the impact of contaminants remains a medium threat and a high research priority. The proposed action may increase turbidity and/or cause dispersion of contaminants during dredging or other remedial activities downstream from the project footprint, but it is expected to have a minimal impact with the implementation of the avoidance and minimization measures, BMPs and compensatory mitigation to offset adverse effects to listed species. The program is expected to benefit green sturgeon by removing a source of contaminants from their critical habitat. Therefore, the proposed action is not likely to appreciably reduce the likelihood of survival and recovery of green sturgeon, even when combined with a degraded environmental baseline and additional pressure from cumulative effects, and climate change.

Sunflower Sea Star. The sunflower sea star is proposed for listing throughout its range, and no data exist to suggest that the species consists of anything other than a single, panmictic population. We are not currently aware of any specific habitat types or locations used by sunflower sea stars for mating or spawning, larvae are planktonic, and newly settled juveniles appear in a variety of habitats. Therefore, to reach a determination of jeopardy, a proposed action would have to impact rangewide population dynamics. Because effects of the proposed action would be limited to a small fraction the sunflower sea star's range, it is not likely to appreciably reduce the likelihood of survival and recovery of the species, even when combined with a degraded environmental baseline and additional pressure from cumulative effects and climate change.

2.7.2 Critical Habitat

The same effects of the proposed action that will have an effect on ESA-listed salmon and steelhead will also have an effect on critical habitat PBFs for salmon and steelhead. Major factors limiting recovery of the ESA-listed species considered in this Opinion include degraded estuarine and nearshore habitat, lack of floodplain connectivity and function, channel structure and complexity, riparian areas and large wood recruitment, fish passage, water quality, harvest and hatchery consequences, predation/competition, and disease. The proposed action is likely to result in the short-term reduction in the quality and function of critical habitat PBFs in the action area during and after dredging and cover layer placement due to water quality and free passage effects, with a medium-term reduction due to forage effects. These reductions, when added to the Environmental Baseline, are small enough in scale that they do not appreciably further degrade baseline conditions or aggravate limiting factors. Beneficial effects will occur as Site clean-up occurs and as compensatory mitigation requirements offset adverse effects to the species in the long-term. As a whole, the critical habitat for migration and rearing is functioning moderately under the current environmental baseline in the action area, and the disruption of the habitat effectuates a continued constraint on the habitat's restoration of natural function by retaining anthropogenic conditions that limit productivity. The remainder of our integration and synthesis for critical habitat will focus on how the effects of the proposed actions, when added to environmental baseline and cumulative effects, impact the ability of PBFs to support the conservation of the listed species described below.

UWR Chinook and steelhead, and LCR Chinook, coho, and steelhead. The critical habitat PBFs within the project footprint for UWR Chinook salmon, UWR steelhead, and the Clackamas populations of LCR Chinook salmon, LCR steelhead, and LCR coho salmon are important for rearing and migration. In-stream and riparian reaches in the mainstem Willamette River, especially below Willamette Falls, Portland Harbor, and other highly developed areas where shallow water and floodplain habitat has been lost or degraded. Access to historical spawning and rearing areas is restricted by large dams in the four historically most productive tributaries, and in the absence of effective passage programs will continue to be confined to more lowland reaches where land development, water temperatures, and water quality may be limiting. Continued land development and habitat degradation, in combination with the potential effects of climate change, may present a continuing strong negative influence into the foreseeable future. Climate change is likely to alter snowpack and result in increased temperature and flow-related changes. Altered flow and temperature, when combined with the degraded baseline and sublethal effects from the program's water quality impacts, may have a cumulative impact. The program will improve habitat quality in Portland Harbor in the long-term as the proposed action with reduce potential risks from contaminated sediments, surface water, groundwater, biota, and adjacent riverbanks within the Site, but these ESUs/DPSs are likely to experience short-term effects from poor water quality, decreased prey, altered riparian and benthic habitat, and impediments to migration. However, the effects of the proposed action, when added to the environmental baseline, cumulative effects, and status of salmonid critical habitat, will not appreciably reduce the quality and function of critical habitat in the action area. Therefore, the program will not impair the ability of this critical habitat to play its intended conservation role of supporting populations of salmonids in the action area.

The critical habitat within the action area for salmon, steelhead, green sturgeon, and eulachon varies by species and their life history. The physical and biological features of salmon and steelhead critical habitat in the action area are freshwater spawning, freshwater rearing, adult and juvenile migration corridors, and estuarine habitat. Salmonids migrating through the action area are generally affected by the same features of critical habitat, though the importance of these features may vary based on the life history strategy of the ESU.

Upper/Middle Columbia River and Snake River ESUs/DPSs. Much of the UCR spring-run Chinook salmon (endangered) and UCR steelhead (threatened) critical habitat is degraded (NMFS 2022c). Both UCR spring-run Chinook salmon and UCR steelhead scored low risk of climate vulnerability in estuary stage sensitivity because of their rapid migration from fresh water to the early marine stage (Crozier et al. 2019). Critical habitat includes the action area, where adults and juveniles migrate through the Lower Columbia River and the Columbia River estuary, important habitat where juvenile salmonids feed and complete the process of acclimating to salt water while avoiding predators. Habitat has improved since the 2016 5-year status review, including in the Lower Columbia River and estuary. While the program will improve habitat quality in Portland Harbor in the long-term, these ESUs/DPSs are likely to experience short-term effects from poor water quality, and impediments to migration. The effects of the proposed action, when added to the environmental baseline, cumulative effects, and status of critical habitat considered in this Opinion, will not appreciably reduce the quality and function of critical habitat in the action area. Therefore, the action will not impair the ability of this critical habitat to play its intended conservation role of supporting the UCR, MCR and SR ESUs and DPS in the action area.

Eulachon. The features of eulachon critical habitat likely to be affected by projects completed under the proposed program are freshwater spawning and incubation sites; and freshwater and estuarine migration corridors; both with water flow, quality, and temperature conditions to support these life stages. The scale of the Lower Columbia River helps to intercept and buffer the short-term impact of construction actions. Similar to salmonids, climate change is likely to alter snowpack and result in increased temperature and flow-related changes. Altered flow and temperature, when combined with the degraded baseline and sublethal effects from the program's water quality impacts, may have a cumulative impact on eulachon. Beneficial effects will occur with Site clean-up and as compensatory mitigation requirements offset adverse effects to the species in the long-term. Overall, the effects of the proposed action will not appreciably reduce the quality and function of critical habitat in the action area. Therefore, the action will not impair the ability of this critical habitat to play its intended conservation role of supporting populations of eulachon in the action area.

Green sturgeon. Water quality is the feature of southern green sturgeon critical habitat that is most likely to be affected by projects completed under the proposed program. The conservation value of critical habitat for sturgeon in the action area is associated with the deeper parts of the Columbia River mainstem channels that are less likely to be affected by projects completed under the proposed program. Climate change may impact green sturgeon spawning outside of the action area due to a change in water temperature and flow, and habitat quality impacts in the estuaries (including the action area) could affect the health of subadult and non-spawning adults from declining habitat quality and prey changes. Based on their use of coastal bay and estuarine habitats, subadults and adults can occupy habitats with a wide range of temperature, salinity, and dissolved oxygen levels, so predicting the impact of climate change in these environments is difficult.

The effects of the proposed action will not appreciably reduce the quality and function of critical habitat in the action area. Beneficial effects will occur as with Site clean-up and as compensatory mitigation requirements offset adverse effects to the species in the long-term. Therefore, the action will not impair the ability of this critical habitat to play its intended conservation role of supporting populations of Green Sturgeon in the action area.

CERCLA-Required Conservation Offsets

In addition to the inclusion of PDCs to minimize the adverse effects of the action, the CWA section 404 requires the action agency to compensate for unavoidable enduring or long-term adverse effects through conservation offsets. The conservation offsets in nearshore and benthic habitats required through compensatory mitigation would replace or provide equivalent substitute resources or environments in Portland Harbor, which is needed to help ensure that salmonids have juvenile rearing and migration areas. Emerging evidence reveals that without sufficient estuary and nearshore habitat, significant life history traits within major population groups are being lost (Campbell et al. 2017). Conservation offset actions would include pile removal, riparian planting, removal of shoreline armoring, or removal of over-water structures, all creating beneficial outcomes for listed species and their critical habitat.

Conservation offsets may also be acquired through the purchase of conservation bank credits, where available. Required conservation offsets will not add to the needed nearshore restoration, but they will ensure that the proposed programmatic action does not cause further degradation of habitat conditions and critical habitat quality. As described above, compensatory mitigation projects will be constructed as part of the proposed action to comply with CWA 404(b)(1) requirements, and the effects of these mitigation projects will generally also offset adverse effects to listed species, such that they are incidentally benefitted. Review and approval of a compensatory mitigation plan (Appendix D) that shows offsets are sufficient to result in a sustained habitat for ESA-listed species will be required by EPA with additional verification from NMFS.

Our conclusions for all species and their critical habitat addressed by this opinion are based on these, as well as the following considerations:

1. Any responsible party receiving EPA authorization will comply with all of the project design criteria. The EPA will submit a pre-construction notification and a compensatory mitigation plan to NMFS and regarding necessary offsets to compensate for unavoidable adverse impacts on ESA species or critical habitat.
2. Taken together, the conservation measures applied to each project will ensure that any short-term effects on water quality, habitat access, habitat elements, channel conditions and dynamics, flows, and watershed conditions will be brief, minor, and scheduled to occur at times that are least sensitive for the species' life-cycle.
3. Based on the undertakings made as part of the proposed action, available information and the NMFS review function built into the administrative procedures of the Portland Harbor programmatic, the frequency of the disturbance will likely be limited up to three remedial projects simultaneously within the Site's 10-mile reach. Thus, there is not expected to be any significant aggregate or synergistic impact of the individual Portland Harbor cleanup projects.
4. By requiring the PDCs to fall within a limited and predictable level of impact, combined with the fact that the programmatic actions are remediating pollution, and that enduring effects will be offset through compensatory mitigation, the overall effects of the proposed action on ESA-listed species will be beneficial.

5. The individual and combined effects of all actions permitted in this way, when taken together with the environmental baseline, status of the species and cumulative effects, are not expected to impair currently properly functioning habitats, appreciably reduce the functioning of already impaired habitats, or slow the long-term progress of impaired habitats toward a proper functioning condition that is essential to the long-term survival and recovery at the population, ESU, or DPS scale.

Most projects carried out under Portland Harbor Cleanup will have short-term adverse effects on critical habitat resulting from construction activities and will impact too small of an area to cause any meaningful loss of critical habitat quality. Moreover, most of these short-term effects ameliorate over time, and habitat will recover. Restoration projects will result in a long-term improvement of critical habitat quality. Projects involving the replacement of structures typically result in a reduction of current impacts and a net improvement in habitat quality due to a more fish-friendly design or removal of contaminants. Some activities, such as capping, result in an enduring loss of critical habitat. However, these activities require compensatory mitigation to offset for such loss from the Portland Harbor Cleanup action.

NMFS does not anticipate that the proposed action would increase the extent of degraded habitat within the basin, add to the long-term degradation of water quality, or further decrease limited rearing areas or limit access to rearing habitat. By contributing to improved habitat conditions that will, over the long term, support populations with higher abundance and productivity, projects completed under the proposed program are consistent with the recovery strategies of increasing productivity and spatial diversity, a critical step toward recovery of these species as whole. This balances the cumulative effects on the habitat and species with the positive long-term effects of the cleanup activities and minimizes the length of time and continued disturbance in the project area to achieve the remedial action objectives. Therefore, the aggregate effects of all projects authorized under the Portland Harbor Cleanup programmatic are not likely to result in appreciable reductions in the likelihood of both survival and recovery of the species in the wild by reducing its numbers, reproduction, or distribution, or reduce the value of designated critical habitat for the conservation of the species, nor will it appreciably impair the ability of critical habitat to serve its intended conservation role.

2.8. Conclusion

After reviewing and analyzing the current status of the listed species and critical habitat, the environmental baseline within the action area, the effects of the proposed action, the effects of other activities caused by the proposed action, and cumulative effects, it is NMFS' biological opinion that the proposed action is not likely to jeopardize the continued existence of LCR Chinook salmon, UWR Chinook salmon, UCR spring-run Chinook, SR spring/summer-run Chinook salmon, SR fall-run Chinook salmon, CR chum salmon, LCR coho salmon, SR sockeye salmon, LCR steelhead, UWR steelhead, MCR steelhead, UCR steelhead, SRB steelhead, eulachon, or green sturgeon, or destroy or adversely modify its designated critical habitat.

2.9. Incidental Take Statement

Section 9 of the ESA and federal regulations pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without a special exemption. “Take” is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. “Harm” is further defined by regulation to include significant habitat modification or degradation that actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including breeding, spawning, rearing, migrating, feeding, or sheltering (50 CFR 222.102). “Harass” is 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.

2.9.1 Amount or Extent of Take

Projects authorized under the Portland Harbor Cleanup programmatic will take place beside and within aquatic habitats that are reasonably certain to be occupied by individuals of the ESA-listed species considered in this opinion. As described below, the proposed action is reasonably certain to cause incidental take of one or more of those species.

In the biological opinion, NMFS determined that incidental take is reasonably certain to occur as follows:

- Injury or death of juvenile salmonids from worksite isolation activities (dewatering, entrainment, and fish capture and handling).
- Harm among juveniles of all ESA-listed salmon and steelhead considered in this opinion due to reduced access to forage species related to the removal of benthic substrate during dredging and/or capping.
- Harm to juveniles and adults of all ESA-listed salmon and steelhead considered in this opinion from temporary increases in suspended sediment and associated contaminants during sediment disturbing activities (e.g., dredging and cover layer placement).
- Harm to juveniles or adults due to pile driving noise.
- Harm to juveniles or adults due to stormwater runoff from the transload facilities.
- Harm due to the presence of in-water and over-water structures.

The take described below cannot be accurately quantified as a number because NMFS cannot directly observe or predict, using the best available science, the number of individuals of listed fish that will be exposed to these stressors. Up-to-date density information is not available; therefore, it is not possible to reliably enumerate or monitor the number of individuals exposed to the action’s stressors. Additionally, there is no practicable means to count the number of fish exposed to the decreased water quality, reduced access to forage, or increased underwater noise because fish will move in and out of an affected area over the period of time during which these effects will occur (periodically throughout the year) and harm to these fish is not necessarily visible

When NMFS cannot precisely predict the number of a species that are reasonably certain to be harmed, captured, or killed, we rely on surrogate measures to assess the extent of take. The most appropriate surrogates for take are action-related parameters that directly relate to the magnitude and duration of the expected take. In such circumstances, NMFS uses the causal link established between the activity and the likely extent and duration of changes in habitat conditions to describe the extent of take as a numerical level of habitat disturbance. Regarding the surrogates described below, the extent is readily observable, and there will be ongoing monitoring to evaluate if the incidental take thresholds are exceeded and the action agency can take curative action if the incidental take thresholds are exceeded based on monitoring and reporting results.

Take indicator for worksite isolation activities and reduced forage opportunities

Worksite isolation activities (dewatering, entrainment, and fish capture and handling) will cause injury or death of juvenile salmonids. NMFS cannot estimate the number of fish injured or killed by from worksite isolation because fish presence at project sites will vary depending on time of years, water temperature, forage distribution and many other factors. Additionally, there are limited ways to count or observe the number of fish exposed to the adverse effects of work area isolation without causing additional risk of injury. The best available indicator for the extent of take during worksite isolation and reduced forage opportunities is one that best describes the dredging efforts relative to the amount of materials dredged. The amount of sediment to be dredged is also an indicator of the size of the area to be dewatered, the amount of fish salvage needed, and benthic habitat disturbed. The extent of take for incidental take caused by dredging is the maximum volume of material dredged per season. This indicator is appropriate for this proposed action because it is directly related to the magnitude of incidental take caused by dredging and fish salvage. We expect the total amount of material dredged to not exceed 366,000 cubic yards per season, based on 3,000 cubic yard per day production rate, and up to three remedial action areas may be dewatered, dredged, or capped at a time.

This volume of material dredged is a rational surrogate for the extent of take because the effects are temporal and spatial in nature, and limiting the actions to likely no more than three simultaneously, with the cubic yard limits expressed above, means that take will be limited to this extent when those actions are underway. This indicator can be reliably measured and monitored because an Action Implementation Worksheets and Action Completion Form (Appendices A and B) are required to be submitted for any action covered under this programmatic, documenting the action agency's verification of the actions' extent. Exceedance of 366,00 cubic yards or dredged material per season for this program functions as a meaningful reinitiation trigger because EPA, responsible parties, and NMFS can track compliance in real time and discover if and when this indicators are exceeded

Take indicator for decreased water quality

Decreased water quality from temporary increases in suspended sediment and associated contaminants during sediment disturbing activities (e.g., dredging and cover layer placement) will cause harm to juveniles and adults of ESA-listed salmon and steelhead considered in this opinion. NMFS cannot estimate the number of fish injured or killed by from decreased water quality because fish presence at project sites will vary depending on time of years, water temperature, forage distribution and many other factors. Additionally, there are limited ways to count or observe the number of fish exposed to the adverse effects of decreased water quality without causing additional risk of harm. The best available indicator for the extent of take from temporary water quality changes is an increase in visible suspended sediment in the water column. This variable is proportional to the water quality impairment construction and dredging will cause, including increased sediment, temperature, and contaminants, and reduced dissolved oxygen. NMFS expects, based on experience, that an increase in turbidity will be visible in the immediate vicinity of project areas and for a distance downstream, and the distance that increased sediment will be visible is proportional both to the size of the disturbance and, therefore, the amount of take that will occur. NMFS expects that for projects with sediment disturbing activities, the elevated levels of suspended sediment and re-suspended contaminants resulting from construction actions will reach background levels within a 300-foot buffer from the point of suspended sediment generation. Listed fish and their prey resources can be harmed from a wide range of elevated sediment levels, and we expect that the harm will cease at the point where sediment levels return to background levels. Thus, the maximum extent of take caused by turbidity levels shall not exceed the take associated with an increase of up to five nephelometric turbidity units (NTUs) above background turbidity levels when the background turbidity is 50 NTUs or less, or there shall not be more than a 10 percent increase in turbidity when the background turbidity is more than 50 NTUs. At no time should turbidity exceed 50 NTUs over background. This limit will be observable as the EPA will monitor turbidity according to PDC 9 (Turbidity Monitoring). Additionally, this potential increase in turbidity shall be limited to within a 300-foot buffer from the activity that causes the increased sediment.

Suspended sediment is rationally connected to the take as described above, and defining the take surrogate as no more than five NTUs or a 10% increase, within the 300-foot buffer, assures that incidental take exceeding levels assumed in the effects analysis will trigger a reinitiation inquiry. The surrogate can be reliably measured and monitored because the suspended sediment can be reliably observed and measured, as reported in the Action Implementation Worksheets and Action Completion Form (Appendices A and B), which are required to be submitted for any action covered under this programmatic.

Take indicator for pile driving noise

Installation or removal of piles will cause underwater sound sufficient to harass, injure, or kill salmon and steelhead. NMFS cannot estimate the number of fish harassed, injured, or killed by pile driving or removal because fish presence at project sites will vary depending on time of years, water temperature, forage distribution and many other factors. Additionally, there are limited ways to count or observe the number of fish exposed to the adverse effects of pile driving without causing additional risk of injury or harassment. The remedial action sequencing scenario indicates that pile driving will not occur concurrently in contiguous areas. The number of piles driven is proportional to the amount of take because each pile driven creates sound that could harass, injure, or kill fish. The risk and total number of fish likely to be exposed increases as more piles are driven. While we don’t know the number of piles that will be driven under the proposed action, we do know that the number of piles (and therefore the amount of incidental take) is related to the number of remediation projects that will occur (along with the transload facilities) as well as the geographic and temporal spread of those projects. Therefore, the best available extent of take is:

- Up to 17 different remedial design project areas occurring with river mile 1.9 to 11.8 and the potential construction of up to three transload facilities.
- Sheetpile or pile driving that is associated with up to three projects occurring concurrently, but not in remedial design project areas contiguous with each other.
- Adherence to the project design criteria across all remedial design project areas to limit impacts from pile driving.

These limits will be observable as EPA will monitor and report on the number and location of projects scheduled to take place both yearly and over the length of the proposed action.

Take indicator for stormwater runoff from transload facilities

Stormwater runoff from the new transload facilities would result in delivering a wide variety of pollutants to aquatic ecosystems, such as nutrients, metals, petroleum-related compounds, and sediment washed off the road surface, which results in a short-term reduction in water quality which would cause injury to fish depending on level of exposure.

This take cannot be accurately quantified as a number of individuals of ESA-listed species because the distribution of those pollutants also vary widely within that waterbody as a function of surrounding land use, pre-rainfall conditions, rainfall intensity and duration, and mixing from other drainage areas. Additionally, there is no practicable means to count the number of fish exposed to the decreased water quality because fish will move in and out of an affected area and harm to these fish is not necessarily visible. Therefore, NMFS will rely on a surrogate for take caused by stormwater runoff from the transload facilities. The surrogate is compliance with the indicator thresholds included in an effectively implemented stormwater management plan for the facilities.

Submission of a stormwater management plan with review and verification by NMFS will not provide a specific measurement of watershed health. However, compliance with the plan development and review requirements reflects the extent of take because the specific thresholds of the approved plan correlate with the level of stormwater treatment that was assumed in the Opinion, and an NMFS-approved plan would be expected to keep those effects within limits which minimize any incidental take. Any substantive non-compliance with the stormwater plan requirements could result in take at levels that go beyond what was analyzed in the Opinion, and therefore require review. The reliance on an implemented plan functions as a meaningful reinitiation trigger because EPA, responsible parties, and NMFS can track compliance in real time and discover if and when these indicators are exceeded.

Take indicator for in-water and over-water structures

In- and over-water structures will cause harm to due to a slight increase in predation or a small increase in migration time, or the element of forage may be degraded for years or permanently from capping. NMFS cannot estimate the number of fish harmed by the presence of in- and over-water structures because fish presence at project sites will vary depending on time of years, water temperature, forage distribution and many other factors. Additionally, there are limited ways to count or observe the number of fish exposed to the adverse effects of in- and over-water structures without causing additional risk of injury. The physical size (square feet) of an in- or over-water structure is the best available surrogate for the extent of take from exposure to the structure itself and also the accompanying impacts. This is because the likelihood of avoidance and the distance required to swim around the structure (migration delay) would both increase as the size of a structure and the intensity of its shadow increase, which would increase the number of juveniles that enter deeper water where forage efficiency would be reduced and vulnerability to predators would be increased. The amount of overwater structure directly determines the amount of shaded area, migration obstruction, reduced benthic productivity and aquatic vegetation, and limiting feeding opportunities available at the project sites (effects further described in Section 3.5).

Based on our review of the ROD and the biological assessment, we expect each transload facility to have a 22,000-square-foot-deck. Therefore, the amount of take associated with in-water and over-water structures is that associated with up to an increase of 22,000 square feet in structures placed in or over the water. This will be reported by the EPA during construction of any transload facility.

Table 4. Incidental take pathways and associated indicators of the amount or extent of incidental take.

Incidental Take Pathway	Amount or Extent of Incidental Take
Harassment, capture, entrainment, injury or death of juvenile fish at in-water work area construction sites Harm among juveniles due to reduced access to forage species related to the removal of benthic substrate during dredging and/or capping	Not to exceed 366,000 cubic yards dredging per season, based on a 3,000 cubic yards dredging per day production rate, and up to three remedial action areas may be dewatered, dredged, or capped at a time, provided the remedial action areas are not contiguous with each other.
Construction and dredging related disturbance (suspended sediment/turbidity, and contaminants).	Turbidity levels shall not exceed 5 nephelometric turbidity units (NTUs) more than background turbidity when the background turbidity is 50 NTUs (monitored and reported to NMFS and the EPA) or less, or there shall not be more than a 10 percent increase in turbidity when the background turbidity is more than 50 NTUs
Pile driving	Up to 17 different remedial design project areas spanning from river mile 1.9 to 11.8 and the potential construction of up to 3 transload facilities will be addressed and constructed during the full term of the remediation action; Sheetpile or pile driving that is associated with likely up to 3 projects occurring concurrently, but not in remedial design project areas contiguous with each other; and Adherence to the project design criteria across all remedial design project areas.
Stormwater management from transload facilities	Implementation of an approved stormwater management plan and compliance with the thresholds contained in the plan.

Incidental Take Pathway	Amount or Extent of Incidental Take
Harm due to the presence of in-water and over-water structures and vessels	22,000 square feet of in-or over-water structure for each new transload facility

Take estimate for monitoring actions

Under the proposed action, the responsible parties, or their contractors, are required to implement various sampling activities. Many of these monitoring and evaluation actions will result in incidental take, a major portion of which takes the form of unintentional capture of ESA-listed fish while conducting sampling targeting other fish or materials. These kinds of activities are typically associated with harassment of ESA-listed fish, which generally leads to stress and other sub-lethal effects caused by observing, capturing, and handling fish even though they are ultimately released, and a small number may be unintentionally killed as a result of such activities. Take in the form of intentional capture, tissue sampling, or lethal sacrifice of ESA-listed fish for contaminant analysis required for monitoring is also considered incidental to, and not the purpose of, the Portland Harbor cleanup activities and is, therefore, also exempted through this incidental take statement. Incidental take from post clean-up monitoring may include harassment, handling, injury, and mortality of naturally or hatchery-produced adults and juveniles of any of the ESA-listed salmon and steelhead considered in this opinion at any location within the action area. NMFS' estimate of the take that is likely to be experienced by the salmon and steelhead species considered in this opinion is provided in the table below.

Table 5. Amount of incidental take of ESA-listed salmon and steelhead associated with post clean-up monitoring activities (refers to all species present in the action area).

Monitoring Activity	ESA Species Life Stage(s) Affected	Take Mechanism	Annual Amount or Extent of Take
Collection of water, porewater, sediment, invertebrate, or vegetation samples	Juveniles	Unintentional capture or entrainment in sampling equipment	Mortality of up to two individuals per year of any fish species considered
Collection of fish or invertebrate tissue samples of non-ESA listed species (i.e., white sturgeon and resident fish)	Juveniles and adults	Unintentional capture in sampling gear (e.g., nets, traps, hook and line, present in electrofishing field, etc.)	Mortality of up to 1 percent of non-target fish handled
Collection of fish tissue samples from ESA-listed species for contaminant analysis	Juveniles and adults	Intentional lethal sacrifice of ESA-listed fish to obtain liver, muscle, and other tissue samples for contaminant analyses, and unintentional capture of additional fish associated with those sampling events	Handling of up to five adults of any species per year, and mortality of up to two hatchery-origin adults from any species per year Mortality of up to 250 hatchery-origin and 250 natural-origin juveniles per species per year, and handling of an

Monitoring Activity	ESA Species Life Stage(s) Affected	Take Mechanism	Annual Amount or Extent of Take
			additional 250 hatchery-origin and 250 natural-origin juveniles per species per year
Studies of ESA-listed fish presence/habitat use	Juveniles	Intentional capture in seines, nets, or traps for the collection of habitat use, diet, and morphometric data	Mortality up to 1 percent of fish handled (i.e., captured in nets, seines, traps, or by electrofishing)

2.9.2 Effect of the Take

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

2.9.3 Reasonable and Prudent Measures

"Reasonable and prudent measures" are measures that are necessary or appropriate to minimize the impact of the amount or extent of incidental take (50 CFR 402.02). The following measures are necessary and appropriate to minimize the impact of incidental take of listed species from the proposed program.

The EPA shall:

1. Minimize incidental take by ensuring that all applicable design criteria, general construction measures and compensatory mitigation requirements of the proposed action for all projects carried out under this programmatic action.
2. Ensure completion of a monitoring and reporting program.

2.9.4 Terms and Conditions

In order to be exempt from the prohibitions of section 9 of the ESA, the Federal action agency must comply (or must ensure that any applicant complies) with the following terms and conditions. The EPA or any applicant has a continuing duty to monitor the impacts of incidental take and must report the progress of the action and its impact on the species as specified in this ITS (50 CFR 402.14). If the entity to whom a term and condition is directed does not comply with the following terms and conditions, protective coverage for the proposed action would likely lapse.

1. To implement reasonable and prudent measure 1:
   a. **The EPA shall send project notifications with all required information (as described in Section 1.3.2) to the NMFS inbox for this programmatic (PH-CERCLA.wcr@noaa.gov).**
   b. **Applicants shall report any non-compliance with applicable design criteria, general construction measures and compensatory mitigation requirements to NMFS (PH-CERCLA.wcr@noaa.gov immediately as it occurs during project**

construction, and implement remedial actions right away to rectify any non-compliance.

c. **The EPA shall include compliance with the proposed action and this incidental take statement as a condition of the EPA's approval for projects authorized under this programmatic.**

2. To implement reasonable and prudent measure 2:
   a. The EPA shall provide NMFS (PH-CERCLA.wcr@noaa.gov) annually by February 15 a report that includes an assessment of overall program activity, a map showing the location and type of each action carried out under this opinion, and any other data or analyses the EPA deems necessary or helpful to assess habitat trends as a result of the actions covered under this opinion.
   b. A meeting of the EPA and NMFS will be held my March 31 annually after submission of the annual report to review and discuss the following:
      i. Total project implementation under this programmatic.
      ii. Consistency with the requirements of this programmatic.
      iii. Potential revisions to the programmatic to improve program efficiencies and conservation outcomes.

2.10. Conservation Recommendations

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

- NMFS recommends that the EPA evaluate web-based reporting to lessen the administrative burden, with the goal of improving completion reporting and tracking of incidental take.
- NMFS recommends the EPA and Responsible Parties continue to implement additional actions to improve habitat complexity within the Portland Harbor Superfund site whenever possible.

Please notify NMFS if the EPA carries out these recommendations so that we will be kept informed of the actions that minimize or avoid adverse effects and those that benefit the listed species or their designated critical habitats.

2.11. Reinitiation of Consultation

This concludes formal consultation for Portland Harbor Superfund site cleanup activities.

As 50 CFR 402.16 states, 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 if: (1) The amount or extent of incidental taking specified in the ITS is exceeded, (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this Opinion, (3) the identified action is subsequently modified in a manner that causes an effect to the listed species or critical habitat that was not considered in the biological opinion, or (4) a new species is listed or critical habitat designated that may be affected by the action.

2.12. "Not Likely to Adversely Affect" Determinations

For purposes of the ESA, "effects of the action" means the direct and indirect effects of an action on the listed species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action (50 CFR 402.02). The applicable standard to find that a proposed action is not likely to adversely affect (NLAA) listed species or critical habitat is that all of the effects of the action are expected to be discountable, insignificant, or completely beneficial (USFWS and NMFS 1998). Beneficial effects are contemporaneous positive effects without any adverse effects to the species. Insignificant effects relate to the size of the impact and should never reach the scale where take occurs. Discountable effects are those extremely unlikely to occur.

Southern Resident Killer Whale Determination. SRKWs are at risk of extinction in the foreseeable future. The population has relatively high mortality and low reproduction unlike other resident killer whale populations that have generally been increasing since the 1970s (NMFS 2021c). Reduced prey availability and exposure to toxic chemicals are major limiting factors for this species. Southern Resident killer whales spend considerable time in the Georgia Basin from late spring to early autumn, with concentrated activity in the inland waters of Washington State around the San Juan Islands, and typically move south into Puget Sound in early autumn (NMFS 2008). Pods make frequent trips to the outer coast during this season. In the winter and early spring, SRKW move into the coastal waters along the outer coast from the Queen Charlotte Islands south to central California, including coastal Oregon and off the Columbia River (NMFS 2008). The waters at the mouth of the Columbia River are known to be a high-use area for Southern Resident killer whales in the winter.

The major environmental threats to SRKW include prey availability, pollution/contamination, vessel effects, oil spills, and acoustic effects (NMFS 2008). Of those, only prey availability and pollution/contamination may be affected by the proposed action. Chinook originating from the Snake and Columbia Rivers are important food sources for this species (Hanson et al. 2021); other fish species eaten include steelhead, and non-salmonid fish species. Hanson et al. (2021) performed genetic analysis of SRKW fecal and prey samples, and found that 53.6 percent of the Chinook salmon consumed in mid-winter and spring in coastal waters originated in the Columbia River, with the highest percentage coming from the LCR spring, MCR tule, LCR fall, and UCR summer/fall Chinook salmon ESUs.

Contaminants such as PCBs, PBDEs, and DDTs are lipophilic, bioaccumulating in fat stores of SRKWs. When prey is scarce, contaminant exposure increases due to metabolization of lipid stores, and increased exposure is linked to impaired reproduction and lowered immune response (Lundin et al. 2016). Bioaccumulation increases with age, with the exception of females that transfer contaminants to calves during pregnancy and lactation (Lundin et al. 2016). Thus, fewer prey and higher contaminants are likely impacting the recovery of this species.

Though the proposed program may cause a very small reduction in the quality or quantity of their preferred prey, any salmonid take including Chinook salmon up to the aforementioned amount and extent of take would result in an insignificant reduction in adult equivalent prey resources for SRKW that may intercept these species within their range. This program will improve sediment quality in the long term and will lead to benefits for listed salmonid species by addressing and removing a known source of chemical contamination. Given the total quantity of prey available to SRKWs throughout their range numbers in the millions, the reduction in prey related to short-term construction effects from the proposed action is extremely small.

Because the presence of SRKW in the action area is extremely unlikely, adverse effects due to short-term construction effects are not likely to adversely affect SRKW.

Moreover, because the number of juvenile Chinook salmon that consume contaminated prey at the site would be very low, and because only a small subset of those individuals may be consumed by SRKW, the action is extremely unlikely to cause detectable levels of contaminants in SRKW. Therefore, the effects of contaminated forage on SRKW are discountable.

NMFS concurs with the EPA's determination that the proposed action is not likely to adversely affect SRKW and their designated critical habitat.

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 EPA and descriptions of EFH for Pacific Coast groundfish (Pacific Fishery Management Council [PFMC] 2005) and Pacific Coast salmon (PFMC 2014) contained in the fishery management plans developed by the PFMC and approved by the Secretary of Commerce.

3.1. Essential Fish Habitat Affected by the Project

The Pacific Fishery Management Council (PFMC) described and identified EFH for groundfish (PFMC 2005), coastal pelagic species (PFMC 1998), and Chinook salmon, coho salmon, and Puget Sound pink salmon (PFMC 1999). The proposed action and action area for this consultation are described in the Introduction to this document. The action area includes areas designated as EFH for various life-history stages of groundfish, coastal pelagic species, and Chinook and coho. Based on information provided by the action agency and the analysis of effects presented in the ESA portion of this document, NMFS concludes that the proposed actions will have the following adverse effects on EFH designated for Pacific Coast salmon and Groundfish.

The monitoring actions included in the proposed action are not likely, singly or in combination, to adversely affect the habitat upon which Pacific salmon, groundfish, and coastal pelagic species; the post-action monitoring is, therefore, not likely to affect EFH. All the monitoring actions are of limited duration, minimally intrusive, and are entirely discountable in terms of their effects, short- or long-term, on any habitat parameter important to ESA-listed fish.

3.2. Adverse Effects on Essential Fish Habitat

Based on the information provided in the BA and the analysis of effects presented in the ESA portion of this document, NMFS concludes that the proposed actions will have the following adverse effects on EFH designated for those species, including estuarine areas designated at habitat areas of critical concern in the Lower Columbia River and at other river mouths, bays, estuaries, and coastal waters that these projects will affect:

1. *Water quality* will be reduced due to a short-term increase in turbidity, dissolved oxygen demand, and resuspension of contaminants that are associated with activities such as dredging and debris removal. In the long term, water quality is likely to improve as contaminated material is removed or capped at the project site.
2. *Natural cover for fish*, such as riparian vegetation, large wood, and boulders could be reduced or disturbed in the short-term due to removal during remedial activities. Where bank hardening, revetment repair, or other work that could disturb natural cover elements is necessary, the EPA will ensure site restoration or conservation offsets are implemented to achieve not net loss of habitat function.
3. *Forage availability* will temporarily be reduced due to remediation activities such as dredging, work area isolation, and pile driving. Long-term or permanent loss of forage area may result from capping activities, which will alter benthic substrate in such a way that recolonization by forage species may not be possible, or slow to occur. Some native sediment may re-accumulate over the capped areas but there is little certainty regarding the time frame associated with recolonization of forage species or if recolonization would be could be achieved at a level equivalent to that of the pre-disturbed condition or surrounding environment.
4. *Permanent loss of shallow-water habitat and refugia* will occur through the conversion of some shallow-water habitat to deep water where dredging is necessary and backfill with

native material may not be immediate. Where capping is necessary in shallow water areas, some temporary and permanent loss of habitat function is likely to occur.

3.3. Essential Fish Habitat Conservation Recommendations

NMFS expects that fully implementing these conservation recommendations would protect EFH by avoiding or minimizing the adverse effects described in Section 4.2 above for Pacific coast salmon and Pacific coast groundfish:

1. All planned activities should fully implement all relevant project design criteria (PDCs) as outlined in Section 2 of the Programmatic BiOp
2. All responsible parties should implement monitoring practices for all pollutants and turbidity outlined in the Programmatic BiOp; all responsible parties should apply the most rapid monitoring techniques available to ensure “faster decision-making relative to BMPs”
3. EPA should ensure that all responsible parties implement mitigation measures for actions which may require conservation offsets as outlined in the Programmatic BiOp.

Fully implementing these EFH conservation recommendations would protect, by avoiding or minimizing the adverse effects described in Section 4.2, above, for Pacific Coast salmon and Pacific Coast groundfish.

3.4. Statutory Response Requirement

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

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

3.5. Supplemental Consultation

The EPA 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.

Utility

Utility principally refers to ensuring that the information contained in this consultation is helpful, serviceable, and beneficial to the intended users. The intended user of this Opinion is the EPA. Other interested users could include permit or license applicants (Responsible Parties). Individual copies of this Opinion were provided to the EPA. The document will be available within two weeks at the NOAA Library Institutional Repository [https://repository.library.noaa.gov/welcome]. The format and naming adheres to conventional standards for style.

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.

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, if applicable 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. ATTACHMENTS

APPENDIX A
ACTION IMPLEMENTATION WORKSHEETS

Action Implementation Worksheets
1. Action Notification

DATE OF REQUEST:		**National Marine Fisheries Service (NMFS) TRACKING #:**
TYPE OF REQUEST:	☐ ACTION NOTIFICATION ☐ ACTION MODIFICATION	
Lead Action Agency:	**Environmental Protection Agency (EPA)**	EPA Action ID #: ORSFN1002155
Action Agency Contact:		
Performing Party Contact:		
Project Name:		
Proposed Construction Period:	***Start Date:***	***End Date:***
In-Water Work Window	**July 1 – October 31** **December 1 – January 31 (work in water > 20 feet CRD only)**	
Proposed Acreage of In-Water Remediation Activities		
Proposed Length of Riverbank Modification in linear feet:		
Proposed Acreage of Off-Site and/or On-Site Compensatory Mitigation		

Project Description:

Type of Action:

Identify the type of action proposed.

☐ Dredging

☐ In-Water Capping/Material Placement, including armoring

☐ Riverbank Excavation

☐ Riverbank Capping/Material Placement, including armoring

☐ Pile/Sheet Pile Installation and Removal

☐ Removal of Existing Piling

☐ Removal of Debris or Over-Water/In-Water Structures

☐ In Situ Treatment/Solidification/Stabilization

☐ Cap Repair and Maintenance

☐ Coffer Dam/Water Diversion

☐ Fish Exclusion/Fish Screens. If checked, provide engineering analysis of fish passage for NMFS review and NMFS response request must be noted on previous page.

☐ Vegetated Riprap

☐ Placement of Large Wood

☐ Compensatory Mitigation **or On-Site Conservation Offset**

☐ Outfall Relocation

☐ Stormwater Management and/or Treatment

☐ Modification or variance of any requirement (including extension of the in-water work window). If checked, NMFS response request must be noted on previous page.

☐ Installation of in-water structure

☐ Construction associated with Transload Facilities

If Action Modification, describe any changes from the initial/previous Action Notification (i.e., changes to design or implementation):

Terms and Conditions: *Check the Project Design Criteria (PDCs) from the biological opinion that will be used for this proposed action. Please attach all appropriate plan(s) for this proposed action.*

Administrative PDCs

☐ Site Access
☐ Monitoring and Reporting

General In-Water/Near-Water Construction PDCs

☐ Site Layout and Flagging
☐ Staging, Storage, and Stockpile Areas
☐ Erosion Control
☐ In-Water Work Window
☐ Work Area Isolation Methods and Fish Salvage
☐ Spill Response
☐ Physical Sediment Dispersion Control

Dredging PDCs

☐ General Dredge Operation

Capping and Treatment PDCs

☐ Placement of Materials for Capping, In Situ Treatment, ENR, and Residual Management

Piling Removal and Placement PDCs

☐ Piling Removal
☐ Piling Placement

Riverbank Construction PDCs

☐ Riverbank Construction and Stabilization

Transloading Facility PDCs

☐ Barge Loading and Transport
☐ Transload Operation
☐ Stormwater Management

Monitoring PDCs

☐ Water Quality Monitoring
☐ Contaminants of Concern Monitoring
☐ Turbidity Monitoring
☐ Monitoring Long-Term Sediment Loading to the Columbia River

Offsets for Unavoidable Habitat Loss

☐ Measures required to offset impacts on shallow water and riverbank habitats

☐ Riprap
☐ Unavoidable Impact Offsets

In-Water Work Window Extension Request*

(*Requires notification to National Marine Fisheries Service and Oregon Department of Fish and Wildlife)

Project Name:				
Will all other PDCs be implemented? Yes No (explain):				
Proposed Activity	**Location within Project Area (attach figures)**	**Depth (>20' CRD or >20'CRD)**	**Proposed Start Date (include year)**	**Proposed End Date (include year)**

Reason why the work cannot be completed during the approved in-water work window:

Describe any known or anticipated impacts on schedule or sequencing of cleanup if work window extension is not granted:

<u>Describe the location, habitat affected, and the timing/duration of each activity:</u>

<u>Provide average daily fish counts and other information relevant to species and life stage presence and numbers during the proposed in-water work window extension period:</u>

<u>Describe additional BMPs/avoidance and minimization measures and proposed compensatory mitigation:</u>

Pile Installation Worksheet

For Vibratory & Impact Hammer
What is the number of hours/minutes required to drive one pile? Mins/Hours
What is the number of hours/minutes required to drive all piles? Mins/Hours
What is the number of hours per day pile driving will occur? Mins/Hours
What is the depth of water the piles will be driven in? Feet
Substrate Type:
What is the diameter of the piles? Inches
Will pile-driving be continuous? ☐ Yes ☐ No
Will be pile be driven straight or battered? ☐ Straight ☐ Battered
Will a template be used? ☐ Yes ☐ No
Pile type (H, round, etc.)?
When is pile-driving proposed?
What life-stages are known to occur within the action area.
If provided, what is the source of hydroacoustic assumptions?
Installation plan/ schematics included? ☐ Yes ☐ No
Pile spacing? Inches/Feet
Piles wrapped or coated? If yes, state type of material being used. ☐ Yes ☐ No Material Type:
For Impact Hammer Only
What is the number of impact hammer strikes per hour?
If an impact hammer is used, will it be the entire pile or proofing only? ☐ Entire Pile ☐ Proofing
Which of the following sound attenuation methods will be used? ☐ Completely isolate the pile from flowing water by dewatering the area around the pile. ☐ Surround the pile being driven by a confined or unconfined bubble curtain that will distribute small air bubbles around 100 percent of the pile perimeter for the full depth of the water column. **This method is applicable if horizontal water velocity is 1.6 feet per second or less.** ☐ Surround the pile being driven with a confined bubble curtain (e.g., surrounded by a fabric or non-metallic sleeve) that will distribute air bubbles around 100 percent of the pile perimeter for the full depth of the water column. **This method is applicable if horizontal water velocity is greater than 1.6 feet per second.** ☐ No sound attenuation

APPENDIX B
ACTION COMPLETION FORM

2. Action Completion Report

This form shall be submitted within 60 days of completion of all work below ordinary high water (OHW) for each in-water work season. EPA shall submit this form to NMFS at PH-CERCLA.wcr@noaa.gov upon receipt from the performing party.

EPA Action ID #	ORSFN1002155	
Actual Start and End Dates for the Completion of In-water Work:	***Start***:	***End***:
Actual Acreage of Dredging, Capping, and/or Materials Placement (and type)		
Actual Length of Riverbank Modification in linear feet and acres:		
Actual Acreage of Compensatory Mitigation or On-Site Conservation Offset		
Turbidity Monitoring/Sampling Completed	☐ Yes (include details below)	☐ No
Fish Salvage Completed	☐ Yes (include details below)	☐ No

<u>Please include the following:</u>

1. Attach any approved modification(s) that occurred during construction and provide justification for each modification, along with respective EPA approvals.
2. Attach as-built drawings for any sediment or riverbank cap.
3. Describe in-water and riverbank slope angle pre-remedial action and post-remedial action. Describe placement of armoring by habitat type (e.g., riparian, active channel margin, shallow, deep).
4. Attach photos of shoreline habitat conditions before, during, and after action completion in transects that represent all habitat types present.
5. Summarize results of pollution and erosion control inspections, including any erosion control failure, contaminant release, and corrective actions.
6. Describe number, type, and diameter of any pilings and/or treated wood installed, removed, or broken during removal, including locations.
7. Describe water quality monitoring, including field parameters and turbidity including dates, times, and location(s) of monitoring and any exceedances and steps taken to reduce measured turbidity. Include a plot of water quality results (e.g., turbidity NTUs, contaminant of concern [COC] concentrations) on y axis with annotations for BMPs applied, repairs undertaken, and any other events that might impact water quality versus date on x axis.

8. Describe COC monitoring including dates, times, and location(s) of monitoring and any exceedances and steps taken to reduce measured COC concentrations.

9. Attach any mitigation plan and/or a schedule of deliverables for off-site mitigation site acquisition, design, and construction milestones.

APPENDIX C
FISH SALVAGE REPORTING FORM

3. Fish Salvage Report

If applicable: The performing party shall submit a completed Fish Salvage Report and Fish Salvage Data Table (see below) to EPA within 90 days of completing a capture and release as part of an action completed under this biological opinion. EPA will submit the report to NMFS at PH-CERCLA.wcr@noaa.gov.

EPA Action ID #:

____

Date(s) of Fish Salvage Operation(s):

____

Supervisory Fish Biologist:

____

Address:

____

Telephone Number:

____

Describe the methods that were used to isolate the work area and remove fish:

<u>Fish Salvage Data (include a table for every fish salvage event conducted)</u>

Water Temperature: ____

Air Temperature: ____

Time of Day: ____

ESA-Listed Species	Number Handled		Number Injured		Number Killed	
	Juvenile	Adult	Juvenile	Adult	Juvenile	Adult

APPENDIX D
COMPENSATORY MITIGATION WORKPLAN INSTRUCTIONS

4. Compensatory Mitigation

Performing parties shall submit a Compensatory Mitigation Work Plan and a Compensatory Mitigation Completion Report to EPA for applicable actions. By December 31 of any year in which EPA approves a compensatory mitigation plan or finds that compensatory mitigation is complete for any action, EPA will submit the completed Compensatory Mitigation Work Plan and/or Compensatory Mitigation Completion Report with the following information to NMFS at PH-CERCLA.wcr@noaa.gov.

A Compensatory Mitigation Work Plan will include:

- Mitigation objectives
- Factors considered during site selection
- Site protection instrument(s)
- Baseline information about the mitigation site
- Rationale for the determination of credits
- Mitigation work plan
- Maintenance plan
- Performance standards (Performance standards should relate to the objectives of the compensatory mitigation project, so that the project can be objectively evaluated to determine if it is developing into the desired resource type, providing the expected functions, and attaining any other applicable metrics such as acres (40 CFR 230.95).)
- Monitoring requirements (e.g., vegetation data, photo-points).
- Long-term management plan
- Adaptive management plan
- Financial assurances

A Compensatory Mitigation Completion Report will include:

- Description of the location of mitigation work.
- Summary of the results of mitigation work completed, any deviations from the work plan, and achievement of performance standards.
- Photos of compensatory mitigation sites before, during, and after completion.
- As-built drawings for the completed mitigation project.

If mitigation is required but not performed in the same calendar year as loss, describe additional measures that will be taken for the temporal loss of habitat.