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-2024-02427

October 2, 2024

Amy Gibbons
Chief, Environmental Services Branch
Department of the Army
U.S. Army Corps of Engineers, Portland District
P.O. Box 2946
Portland, Oregon 97208-2946

Re: Endangered Species Act Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response for the Baker Bay West Pile Dike Repair Project, HUC 170800060500, Pacific County, Washington

Dear Ms. Gibbons:

Thank you for your letter of September 30, 2024, requesting initiation of consultation with NOAA's National Marine Fisheries Service (NMFS) pursuant to section 7 of the Endangered Species Act of 1973 (ESA) (16 U.S.C. 1531 et seq.) for the Baker Bay West Pile Dike Repair Project.

Thank you also for your request for a conference on the proposed listing of sunflower sea star (*Pycnopodia helianthoides*) as threatened under the ESA.

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. We have concluded that the action would adversely affect EFH designated under the Pacific Coast salmon, Pacific Coast groundfish, and coastal pelagic species Fishery Management Plans.

In the biological opinion we concluded that the proposed action is likely to adversely affect, but not likely to jeopardize the continued existence nor adversely modify the critical habitat of:

1. Lower Columbia River Chinook salmon
2. Upper Willamette River Chinook salmon
3. Upper Columbia River spring Chinook salmon
4. Snake River spring/summer Chinook salmon
5. Snake River fall Chinook salmon
6. Lower Columbia River coho salmon
7. Columbia River chum salmon
8. Snake River Sockeye salmon
9. Lower Columbia River steelhead

10. Middle Columbia River steelhead
11. Upper Columbia River steelhead
12. Upper Willamette River steelhead
13. Snake river Basin steelhead
14. North American green sturgeon
15. Humpback whale-Central America DPS
16. Humpback whale Mexico DPS

We also concluded that the proposed action is not likely to adversely affect the following species or their designated critical habitat:

1. Eulachon
2. Southern Resident killer whales
3. Leatherback sea turtles

We also concur with your determination that the proposed action is not likely to adversely affect sunflower sea star should they become listed. This document will serve as our conference on this species.

As required by section 7 of the ESA, NMFS is providing an incidental take statement with the biological opinion.

Please contact Tom Hausmann, in Portland, Oregon, at 503-231-2315, or tom.hausmann@noaa.gov if you have any questions concerning this consultation, or if you require additional information.

Sincerely,

Kim W. Kratz, Ph.D
Assistant Regional Administrator
Oregon Washington Coastal Office

cc: David Griffith, Fish Biologist, USACE
Craig Cockrell, NOAA Fisheries

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

Baker Bay West Pile Dike Repair Project

NMFS Consultation Number: WCRO-2024-02427

Action Agency: U.S. Army Corps of Engineers

Affected Species and NMFS' Determinations:

ESA-Listed Species	Status	Is Action Likely to Adversely Affect Species?	Is Action Likely to Jeopardize the Species?	Is Action Likely to Adversely Affect Critical Habitat?	Is Action Likely to Destroy or Adversely Modify Critical Habitat?
Lower Columbia River Chinook Salmon (*Onchorhynchus tshawytscha*)	Threatened	Yes	No	Yes	No
Upper Willamette River Chinook	Threatened	Yes	No	Yes	No
Upper Columbia River Spring-run Chinook	Endangered	Yes	No	Yes	No
Snake River Spring-run Chinook	Threatened	Yes	No	Yes	No
Snake River Fall-run Chinook	Threatened	Yes	No	Yes	No
Columbia River Chum Salmon (*O. keta*)	Threatened	Yes	No	Yes	No
Lower Columbia River coho (*O. kisutch*)	Threatened	Yes	No	Yes	No
Snake River Sockeye (*O. nerka*)	Endangered	Yes	No	Yes	No
Lower Columbia River steelhead (*O. mykiss*)	Threatened	Yes	No	Yes	No
Upper Willamette River steelhead	Threatened	Yes	No	Yes	No
Middle Columbia River steelhead	Threatened	Yes	No	Yes	No
Upper Columbia River steelhead	Threatened	Yes	No	Yes	No
Snake River Basin steelhead	Threatened	Yes	No	Yes	No
Humpback whale (*Megaptera novaeangliae*) Central America DPS	Endangered	Yes	No	NA	NA
Humpback whale Mexico DPS	Threatened	Yes	No	NA	NA
Green sturgeon (*Acipenser medirostris*)	Threatened	Yes	No	Yes	No
Leatherback sea turtle (*Dermochelys coriacea*)	Endangered	No	No	NA	NA

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
Groundfish	Yes	Yes
Coastal Pelagic Species	Yes	Yes

Consultation Conducted By: National Marine Fisheries Service
West Coast Region

Issued By:

Kim W. Kratz, Ph.D.
Assistant Regional Administrator
Oregon Washington Coastal Office

Date: October 2, 2024

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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.), as amended, and implementing regulations at 50 CFR part 402.

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

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

1.2. Consultation History

1. In 1993, the USACE and NMFS consulted on maintenance dredging of the Middle Columbia River (MCR), Lower Columbia River (LCR), Lower Willamette River (LWR) Federal Navigation Channels (FNC) and several side FNCs including the Baker Bay West (BB or BBW) FNC. In 1999, 2005, and 2012 the USACE reinitiated the 1993 Biological Opinion to consult on the effects of maintenance dredging and disposal of dredge material on species listed under the ESA since 1993.

2. In 2016, NMFS and the USACE pre-consulted on pile dike rehabilitation design. NMFS cautioned that recreating 200+ timber pile dikes would adversely affect ESA listed salmon and steelhead due to obstructed shallow water passage and predation from birds using the piles for hunting perches. To reduce potential adverse effects on listed species, the USACE reexamined the pile dike design and reduced or eliminated timber piles and increased the height of the rock base to just below mean lower low water. The USACE Engineer Research and Development Center (Hammack, Johnston and Smith 2019) compared conventional pile dikes and rock dikes and found their effects on flow velocity were essentially the same.

3. In August 20, 2019, USACE and NMFS did a site visit to BBW FNC pile dike. NMFS requested the USACE minimize the project scope. The USACE determined that project goals would be achieved by repairing BB 0.28 rather than replacing all four pile dikes. On June 3, 2020, USACE presented their plan to NMFS, adding 3 shallow water fish passage notches to Baker Bay pile dike at river mile 0.28 (BB 0.28).

4. In 2022, NMFS consulted on WCRO-2020-02758 Sand Island Pile Dike Repair Project. The proposed dike increased the height of the rock base, eliminated timber piles from 75 percent of the dike length, and installed 175 steel pipe piles at the FNC end of the dike. The consultation concluded that this design eliminated the passage obstruction effect, greatly reduced the avian predation effect and noted that fish used the low velocity downstream flow for resting habitat at night.

5. On March 14, 2022, the USACE sent NMFS a Biological Assessment (BA) and requested initiation of consultation on rehabilitation of the Baker Bay pile dike system, specifically BB 0.28 (then numbered WCRO 2022-00564). On April 8, 2022 NMFS requested additional information on water quality BMPs and measures to prevent marine mammal harassment.

6. On January 8, 2024, the USACE sent NMFS a revised BA and request to consult on BB 0.28. The USACE determined that the proposed action was likely to adversely affect: Lower Columbia River Chinook salmon, Upper Willamette River Chinook salmon, Upper Columbia River spring Chinook salmon, Snake River spring/summer Chinook salmon, Snake River fall Chinook salmon, Lower Columbia River coho salmon, Columbia River chum salmon, Snake River Sockeye salmon, Lower Columbia River steelhead, Middle Columbia River steelhead, Upper Columbia River steelhead, Upper Willamette River steelhead, Snake river Basin steelhead, and green sturgeon and designated critical habitat for these species. The USACE determined that the proposed action is not likely to adversely affect eulachon, Southern Resident killer whale (SRKW), humpback whales, leatherback sea turtle, or sunflower sea star or the designated critical habitats of these species.

7. NMFS issued a Biological opinion (WCRO-2024-00028) on September 11, 2024. Due to unforeseen errors, NMFS rescinded the opinion on September 27, 2024.

8. On September 30, 2024, the USACE submitted new consultation materials, including a BA and project modifications. NMFS initiated consultation on September 30, 2024.

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 (see 50 CFR 402.02).

The USACE proposes to repair the BB 0.28 pile dike authorized and constructed under the Rivers and Harbors Act of 1945. The current dike is composed of wooden piles and rock, which will be replaced with a rocked dike featuring fish migration notches and warning signs posted on 12 steel piles (marker piles) 12 – 24 inches in diameter. The Baker Bay West Pile Dike (BBW Pile Dike) system narrows the cross section of the channel between West Sand Island and Jetty A, focusing currents through the Baker Bay West Federal Navigation Channel (BBW FNC) to help sustain authorized depths for navigation. The BBW FNC is 2.9 miles long, 150 to 200 feet wide and 16 feet deep and connects the Port of Ilwaco to the Mouth of the Columbia River FNC at RM 3.25. The action is needed because years of deferred maintenance have led to deterioration of the BBW pile dike. The properly functioning BBW pile dike also reduces the frequency of maintenance dredging in the FNC, the Port of Ilwaco and the United States Coast Guard Cape Disappointment Station and reduces erosion of the West Sand Island shoreline and a shoal next to Jetty A. BB 0.28 is the longest of the four dikes in the system and the only one that will be repaired under this proposed action.

The proposed action consists of:

1. Develop a temporary facility for offloading equipment and construction material (MOF) on to West Sand Island between pile dike BB 0.86 and pile dike BB 0.70 by either: A. constructing a land peninsula into the channel with a backfilled cofferdam or B, installing a floating transition barge from the beach into the channel (**Figure 1**).

    A. The land peninsula cofferdam would be constructed from 200 feet of sheet piles (approximately 125, 24-inch and 30-inch wide sheet piles). Sheet piles will be installed with a vibratory pile driver. The estimated maximum vibratory pile driver time is 1,250 minutes for installation and 150 minutes for removal. Once the cofferdam is closed, any fish trapped inside will be captured and released. The cofferdam will be backfilled with granular material. About 25,000 cubic yards (cy) of sediment will be dredged from the channel at the end of the peninsula to provide depth for barges carrying material and equipment to moor at the end of the peninsula.
    B. The floating transition barge will have one barge spudded in place to reach sufficiently deep water such that material and equipment transport barges can moor to and transport material to land across the transition barge. Approximately 2,800 cubic yards of material will be dredged to provide depth for equipment and material barges. Sixteen steel piles in 4 clusters (dolphin moorings) will be installed with a vibratory hammer to moor the material barges as they offload to the transition barge.

Figure 1. Peninsula MOF (Top) and barge MOF (Bottom).

2. **Figure 3** shows the profile of BB 0.23. The yellow line is the existing elevation and the solid black line is the proposed elevation. The yellow line spanning the space between MLLW and MHHW from Station 13 to Station 24 represents 486 timber piles remaining from the original structure, which currently extend about 10 ft above MLLW (Nav 88). These piles obstruct fish passage, provide roosts for avian predators of salmon and steelhead and are not necessary for the dike to function (Hammack, Johnston et al. 2019). They will be removed by pulling, cutting or snapping at the enrockment level and disposed of at an upland facility. Vibratory hammers will not be used to remove the timber piles. The piles will be replaced with rock fill in the same footprint as the removed pile. Excavation of the substrate will not occur in this section of the proposed rock dike. The rock dike elevation will be at 0 MLLW (Nav 88), and thus would be submerged most of the time.

3. BB 0.28 is 3,439 feet long with approximately 300 feet on West Sand Island above ordinary high water (OHW). Approximately, 2,800 feet of dike exists on the east side of the FNC and 600 feet of dike exists on the west side of the FNC. The proposed dike cross section is a prism approximately twice as wide at the base as at the top. When complete, the rock dike will occupy approximately 206,000 sf. Where the entire dike must be replaced (Station 1 to Station 13, figure 3), it is composed of an upper armor layer, a middle core layer, and a filter layer between the rock and the channel substrate. Armor stones weigh between 1875 and 3125 pounds. Core stones weigh between 1.5 and 20 pounds and filter stones are up to 4 inches in diameter. The USACE proposes to repair the dike by replacing rock using land based and barge-based excavators and cranes. The dike will be built to an elevation at or below MLLW allowing fish to pass over the top at most tidal stages. An equipment barge will be moored adjacent to the rock barge. The contractor will be required to place rock onto the dike and must not open the bucket until it is below the water surface. For placing rock near or above the water surface, where opening the bucket below the surface is not possible, the contractor must place the bucket as close as safely possible to the placement location before opening. Releasing rocks from a bucket above the water surface will not be permitted. During rock removal and placement, the USACE would work closely with the contractor to

regularly assess subsurface conditions and grades via conditional hydrographic surveys, taking corrective actions as necessary. The contractor will perform hydrographic and topographic surveys pre-construction and post construction to ensure proper rock placement.

4. The top of the dike at the West Sand Island base is 17 feet above MLLW and the dike slopes down for 900 feet.

5. The contractor will add notches for juvenile fish passage along the shoreline during low water. The dike will be constructed with three 50-foot-wide at the top and 20-foot-wide at the bottom and 2-foot deep notches (**Figure *2***) located 300 feet apart and 600, 900 and 1200 feet from the base of the dike. The bottom of the 900 and 1200 notches are under 2 feet of water 95 percent of the time and the bottom of the 600-foot notch is under 2 feet of water 70 percent of the time (**Figure 3**).

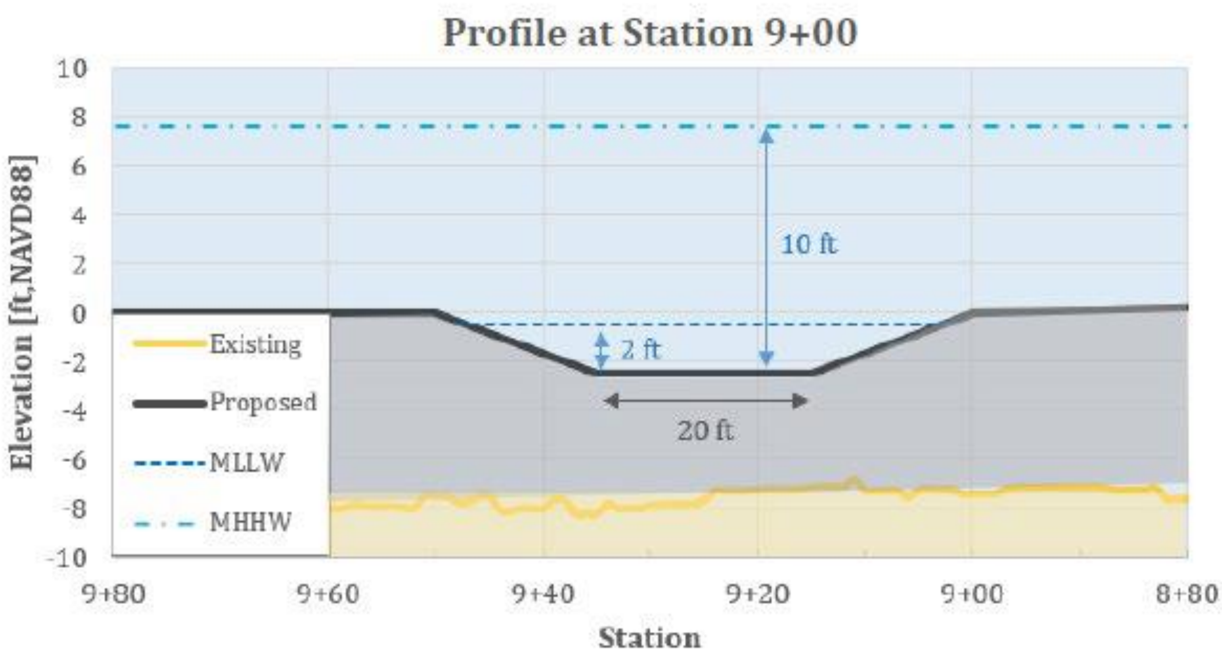

Figure 2. Shallow water fish passage notch.

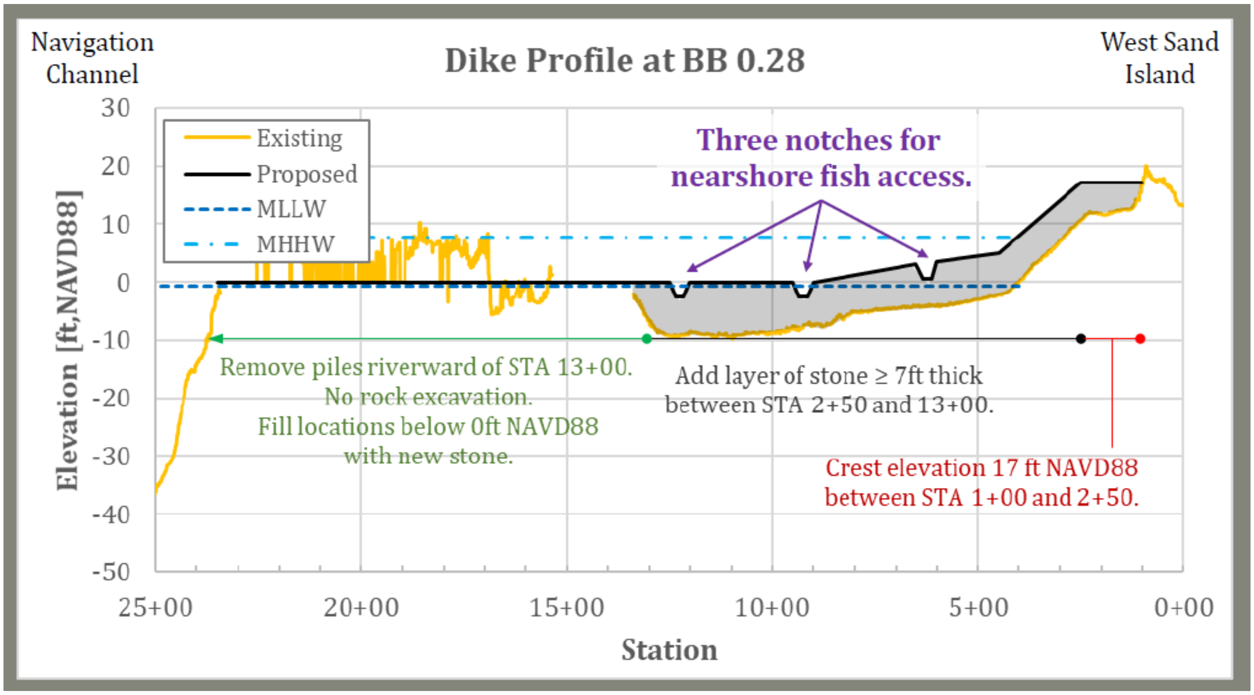

Figure 3. Location of shallow water fish passage notches.

6. Place 6-inch cobble on top of 1-inch diameter filter rock along 500 feet of West Sand Island beach above (upstream) BB 0.28 to protect the base of the dike and shoreline from erosion.

7. Place brush, root masses, logs, branches and sand in the dune low point at the landward end of the dike.

8. Install 12 partially submerged steel marker piles 12 -24-inch diameter with bird deterrents as close to the dike crest as possible using both vibratory and impact hammers during 2 days between August 1 and November 30. The hazard piles (or marker piles) will be in place permanently as aids to navigation and as warnings to boaters. The Corps proposes to use 24-inch steel piles for sound impact calculations and installation timing. Each pile will require on average 26 minutes of vibratory pile driving and 43 impact hammer strikes per minute for 11 minutes/pile equals 473 strikes per pile. A bubble curtain will be used if water conditions permit, but the Corps has assumed that no noise dampeners will be used in their sound calculations due to uncertainty.

9. The project will install four dolphins to moor the rock barge. Each dolphin consists of four 24-inch steel piles (16 total dolphin piles). The dolphins will be spaced along the length of the future barge location, to keep the rock barge in place during offloading, and will be installed using a vibratory hammer. The piles will be installed in August, over an estimated period of two days (8 piles/day). The dolphin piles will be removed after completion of the pile dike also using a vibratory hammer.

10. The USACE proposes to implement the project in two construction seasons, in 2024 and 2025. The USACE intends to carry out in-water work during the months of July through November because life and safety issues associated with wave action and storm activity prevent the USACE and its contractors from working during the winter months in the mouth of the Columbia River. In order to minimize impacts the USACE will include the following requirements in the specifications:
    - In order to avoid vessel strikes with marine mammals, in-water work will be restricted to daylight hours, when marine mammals are visible. Work will begin no sooner than 30 minutes after sunrise and would stop no later than 30 minutes before sunset. This will minimize the possibility of vessel strikes on marine mammals and allow observers time to determine marine mammal presence in the work zone.
    - The USACE will complete enrockment work after 1-August of each work season to reduce impacts to listed species.
    - Barge landings on West Sand Island will be done as quickly as possible to avoid blocking nearshore salmonid migration longer than necessary to offload equipment.
    - All pile driving for this project will be done between after August 1st and November 30th. The USACE anticipates removal of sheet piles at the end of season 1 if option A is selected. If the MOF is not removed at the end of season 1, the contractor will remove MOF at the completion of work Season 2, no sooner than August 1st of Season 2.

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

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

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 to adversely modify or destroy their designated critical habitat. Per the requirements of the ESA, federal action agencies consult with NMFS, and section 7(b)(3) requires that, at the conclusion of consultation, NMFS provide an opinion stating how the agency's actions would affect listed species and their critical habitats. If incidental take is reasonably certain to occur, section 7(b)(4) requires NMFS to provide an ITS that specifies the impact of any incidental taking and includes reasonable and prudent measures (RPMs) and terms and conditions to minimize such impacts.

The USACE determined the proposed action is not likely to adversely affect eulachon, Southern Resident killer whales (SRKW) or leatherback turtles or their critical habitat. Our concurrence is documented in the "Not Likely to Adversely Affect" Determinations section (Section 2.11).

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

The designations of critical habitat for salmon, steelhead, and green sturgeon use the term primary constituent element (PCE) or essential features. The 2016 final rule (81 FR 7414; February 11, 2016) that revised the critical habitat regulations (50 CFR 424.12) replaced this term with physical or biological features (PBFs). The shift in terminology does not change the approach used in conducting a "destruction or adverse modification" analysis, which is the same regardless of whether the original designation identified PCEs, PBFs, or essential features. In this biological opinion, we use the term PBF to mean PCE or essential feature, as appropriate for the specific critical habitat.

The ESA Section 7 implementing regulations define effects of the action using the term "consequences" (50 CFR 402.02). As explained in the preamble to the final rule revising the definition and adding this term (84 FR 44976, 44977; August 27, 2019), that revision does not change the scope of our analysis, and in this opinion, we use the terms "effects" and "consequences" interchangeably.

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

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

2.2. Rangewide Status of the Species and Critical Habitat

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

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 (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 5 warmest years on record both on land and in the ocean (2018 was the 4th 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 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 2011, Crozier 2012, Crozier 2013, Crozier 2014, Crozier 2015, Crozier 2016, Crozier 2017, Crozier and Siegel 2018, Siegel and Crozier 2019, Siegel and Crozier 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.

Forests

Climate change will impact 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.

Freshwater Environments

The following is excerpted from Siegel and Crozier (2019), who present a review of recent scientific literature evaluating effects of climate change, describing the projected impacts of climate change on instream flows:

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 ground water 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 and that lie 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.

Marine and Estuarine Environments

Along with warming stream temperatures and concerns about sufficient groundwater to recharge streams, a recent study projects 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%), while 68% 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 have a similar effect on 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).

Climate change effects on salmon and steelhead

In freshwater, 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, and this in turn 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, and 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, although populations of some ESA-listed salmon and steelhead may be able to make use of 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, Scheuerell et al. 2012, Burke, Peterson 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, Buhle 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, Burke 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 a period of 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, Moore 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 el 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 as well as 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, Armstrong 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, Anderson et al. 2019, Munsch, Greene et al. 2022).

2.2.1. Status of Species

Status of LCR Chinook Salmon

Recovery plan targets for this species are tailored for each life history type, and within each type, specific population targets are identified (NMFS 2013a). For spring Chinook salmon, all populations are affected by aspects of habitat loss and degradation. Four of the nine populations require significant reductions in every threat category. Protection and improvement of tributary and estuarine habitat are specifically noted.

For fall Chinook salmon, recovery requires restoration of the Coast and Cascade strata to high probability of persistence, to be achieved primarily by ensuring habitat protection and restoration. Very large improvements are needed for most fall Chinook salmon populations to improve their probability of persistence.

For late fall Chinook salmon, recovery requires maintenance of the North Fork Lewis and Sandy populations which are comparatively healthy, together with improving the probability of persistence of the Sandy population from its current status of “high” to “very high.” Improving the status of the Sandy population depends largely on harvest and hatchery changes. Habitat improvements to the Columbia River estuary and tributary spawning areas are also necessary. Of the 32 DIPs in this ESU, only the 2 late-fall run populations (Lewis River and Sandy River) could be considered viable or nearly so (NWFSC 2015).

Spatial Structure and Diversity. The ESU includes all naturally-produced populations of Chinook salmon from the Columbia River and its tributaries from its mouth at the Pacific Ocean upstream to a transitional point between Washington and Oregon east of the Hood River and the White Salmon River, and includes the Willamette River to Willamette Falls, Oregon, with the exception of spring-run Chinook salmon in the Clackamas River. On average, fall-run Chinook salmon programs have released 50 million fish annually, with spring-run and upriver bright (URB) programs releasing a total of 15 million fish annually. As a result of this high level of hatchery production and low levels of natural production, many of the populations contain over 50 percent hatchery fish among their naturally spawning assemblages.

The ESU spans three distinct ecological regions: Coastal, Cascade, and Gorge. Distinct life-histories (run and spawn timing) within ecological regions in this ESU were identified as major population groups (MPGs). In total, 32 historical DIPs were identified in this ESU, 9 spring-run, 21 fall-run, and 2 late-fall run, organized in 6 MPGs (based on run timing and ecological region; LCR Chinook populations exhibit three different life history types base on return timing and other features: fall-run (or "tules"), late-fall-run (or "brights"), and spring-run.

Abundance and Productivity. Of the seven spring-run DIPs in this MPG only the Sandy River spring-run population appears to be a currently self-sustaining population. Both of the two spring-run historical DIPs in the Spring-run Gorge MPG are extirpated or nearly so. In general, the DIPs in the Coastal Fall-run MPG are dominated by hatchery-origin spawners. In surveys conduct in both 2012 and 2013, no Chinook salmon were observed in Scappoose Creek. Overall, the Fall-run Cascade MPG exhibits stable population trends, but at low abundance levels, and most populations have hatchery contribution exceeding the target of 10 percent identified in the NMFS Lower Columbia River recovery plan (Dornbusch and Sihler 2013). Many of the populations in the Fall-run Gorge MPG have limited spawning habitat available. Additionally, the prevalence of returning hatchery-origin fish to spawning grounds presents a considerable threat to diversity. Natural-origin returns for most populations are in the hundreds of fish. The two populations in the Late-Fall-run MPG the most viable of the ESU. The Lewis River late-fall DIP has the largest natural abundance in the ESU and has a strong short-term positive trend and a stable long-term trend, suggesting a population near capacity. The Sandy River late-fall run has not been directly monitored in a number of years; the most recent estimate was 373 spawners in 2010 (Takata 2011).

Limiting factors. Limiting factors for this species include NMFS (2013a):

- 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
- Contaminants

Status of UWR Chinook Salmon

Upper Willamette River (UWR) Chinook salmon were listed as threatened on June 28, 2005 (70 FR 37160). A recovery plan is available for this species (ODFW and NMFS 2011). There are a number of general considerations that affect some or all of the UWR Chinook populations, including high levels of pre-spawning mortality, lack of access to historical habitat, high levels of total dissolved gases (TDG), and a reduction in returning adult abundance between Willamette Falls and census points in the main tributaries (NWFSC 2015). Pre-spawning mortality levels are generally high in the lower tributary reaches where water temperatures and fish densities are the highest. 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 confine spawning to more lowland reaches where land development, water temperatures, and water quality may be limiting. Areas immediately downstream of high head dams may also be subject to high levels of total dissolved gas (TDG), which could affect a significant portion of the incubating embryos, in-stream juveniles, and adults in the basin (NWFSC 2015). Shortfalls in counts of returning adults between Willamette Falls and upper tributary reaches also indicate additional pre-spawning mortality or spawning in lower quality habitat in lower tributary reaches could be limiting the recovery of these populations (Jepson et al. 2013; Jepson et al. 2014).

Spatial Structure and Diversity. This species includes all naturally spawned populations of spring-run Chinook salmon originating from the Clackamas River; from the Willamette River and its tributaries above Willamette Falls; and from six artificial propagation programs (USDC 2014, NMFS 2016c). All seven historical demographically independent populations (DIPs) of UWR Chinook salmon identified by the WLC-TRT occur within the action area and are contained within a single ecological subregion, the western Cascade Range (Table 1).

Abundance and Productivity. Abundance levels for five of the seven DIPs in this ESU remain well below their recovery goals. Of these, the Calapooia River may be functionally extinct and the Molalla River remains critically low (although perhaps only marginally better than the 0 VSP score estimated in the Recovery Plan (ODFW and NFMS 2011)). Abundances in the North and South Santiam rivers have risen since the 2010 review, but still range only in the high hundreds of fish. The proportion of natural-origin spawners improved in the North and South Santiam basins, but was still well below identified recovery goals. Improvement in the status of the Middle Fork Willamette River relates solely to the return of natural adults to Fall Creek, however the capacity of the Fall Creek basin alone is insufficient to achieve the recovery goals for this DIP. The Clackamas and McKenzie Rivers have previously been viewed as natural population strongholds, but have both experienced declines in abundance despite having access to much of their historical spawning habitat. Fish passage improvements made at dams and numerous habitat restoration projects completed in upper Willamette River tributaries are expected to eventually provide benefit to the UWR Chinook salmon ESU, however, the scale of improvements needed is greater than the scale of habitat actions implemented to date (NMFS 2016c). Overall, populations appear to be at either moderate or high risk, there has been likely little net change in the VSP score for the ESU since the last review, so the ESU remains at moderate risk (Ford 2022).

Table 1. Scores for the key elements (A&P, diversity, and spatial structure) used to determine current overall viability risk for UWR Chinook salmon (ODFW and NMFS 2011). All populations are in the Western Cascade Range ecological subregion. Risk ratings included very low (VL), low (L), moderate (M), high (H), and very high (VH). The current general directions of population viability scores based on data reviewed in the 2015 status update are also shown (NWFSC 2015).

Population (Watershed)	A&P	Diversity	Spatial Structure	Overall Extinction Risk	Current VSP Score Trend
Clackamas River	M	M	L	M	Declining
Molalla River	VH	H	H	VH	Increasing
North Santiam River	VH	H	H	VH	Increasing
South Santiam River	VH	M	M	VH	Increasing
Calapooia River	VH	H	VH	VH	Stable
McKenzie River	VL	M	M	L	Declining
Middle Fork Willamette River	VH	H	H	VH	Increasing

Limiting Factors. Limiting factors for this species include (ODFW and NMFS 2011):

- Degraded freshwater habitat, including floodplain connectivity and function, channel structure and complexity, incubation gravels, riparian areas, and gravel and large wood recruitment
- Degraded water quality including elevated water temperature and toxins
- Increased disease incidence
- Altered stream flows
- Reduced access to spawning and rearing habitats due to migration barriers, impaired fish passage, and increased pre-spawn mortality associated with conditions below dams. Altered food web due to reduced inputs of microdetritus
- Predation by native and non-native species, including hatchery fish
- Competition related to introduced races of salmon and steelhead
- Altered population traits due to fisheries, bycatch, and natural origin fish interbreeding with hatchery origin fish

Status of Snake River Spring/Summer-run Chinook Salmon

NMFS adopted a final recovery plan for this species in November of 2017 (NMFS 2017a). At least one-half the populations historically present (minimum of two populations) should meet viability criteria (5 percent or less risk of extinction over 100 years). At least one population should be highly viable (less than 1 percent risk of extinction). For MPGs with only one population, this population must be highly viable (less than 1 percent risk of extinction).

Spatial Structure and Diversity This species includes all naturally-spawned populations of spring/summer-run Chinook salmon originating from the mainstem Snake River and the Tucannon River, Grande Ronde River, Imnaha River, and Salmon River subbasins, and from 11 artificial propagation programs (USDC 2014). The IC-TRT recognized 27 extant and four extirpated populations of SR spring/summer-run Chinook salmon, and aggregated these into five MPGs that correspond to ecological subregions (Table 2) (IC-TRT 2003; McClure et al. 2005). All extant populations face a "high" risk of extinction, Ford 2022). Most of the populations also exhibit reduced spatial structure and diversity.

Abundance and Productivity Low abundance and poor productivity remain the primary obstacles to viability for all of the Snake River spring/summer Chinook salmon populations. The latest status review shows that ten Snake River spring/summer Chinook salmon populations increased in both abundance and productivity, seven increased in abundance while their updated productivity estimates decreased, and two populations decreased in abundance and increased in productivity. One population, Loon Creek in the Middle Fork Salmon River MPG, decreased in both abundance and productivity (NWFSC 2015). The relatively low natural production rates and spawning levels below minimum abundance thresholds remain a major obstacle to viability for populations across the ESU. The ability of populations to be self-sustaining in the wild through normal periods of relatively low ocean survival continues to be uncertain.

Table 2. MPGs, populations, and scores for the key elements (A&P, diversity, and SS/D) used to determine current overall viability risk for SR spring/summer-run Chinook salmon (NWFSC 2015). Risk ratings included very low (VL), low (L), moderate (M), high (H), very high (VH), and extirpated (E).

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

Limiting Factors. Limiting factors for this species include (NOAA Fisheries 2011):

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

Status of Snake River Fall-run Chinook Salmon

The NMFS adopted a recovery plan for this species in November 2017. (NMFS 2017b). The long-term recovery goal for natural origin fish is 14,360 average annual returns of natural-origin fall Chinook salmon (adults and jacks) above Lower Monumental Dam. The long-term goal for hatchery origin fish is average annual return goal is 24,750 hatchery-origin fish above Lower Monumental Dam.

Spatial Structure and Diversity This species includes all naturally-spawned populations of fall-run Chinook salmon originating from the mainstem Snake River below Hells Canyon Dam; from the Tucannon River, Grande Ronde River, Imnaha River, Salmon River, and Clearwater River subbasins; and from four artificial propagation programs (USDC 2014).

The IC-TRT identified three populations of this species, although only the lower mainstem population exists at present, and it spawns in the lower main stem of the Clearwater, Imnaha, Grande Ronde, Salmon and Tucannon rivers. The extant population of Snake River fall-run Chinook salmon is the only remaining population from an historical ESU that also included large mainstem populations upstream of the current location of the Hells Canyon Dam complex (IC-TRT 2003; McClure et al. 2005). The population is at moderate risk for diversity and spatial structure VSP criteria (NWFSC 2015).

Abundance and Productivity While the 10-year geometric mean natural-origin abundance level has been high, the abundance/productivity margin is insufficient to rate the population as very low risk with high confidence (i.e., an 80 percent or higher probability of exceeding the 1 percent viability curve). The probability that the true underlying abundance and productivity being estimated from the samples falls above the 5 percent viability curve (with minimum abundance threshold) is, however, greater than 80 percent. As a result, the Lower Snake River fall Chinook salmon population is rated at low risk for abundance and productivity (Ford 2022).

Overall population viability for the Lower Mainstem Snake River fall Chinook salmon population is determined based on the combination of ratings for current abundance and productivity and combined spatial structure diversity (Table 3).

Table 3. Lower Mainstem Snake River fall Chinook salmon population risk ratings integrated across the four viable salmonid population (VSP) metrics. Viability Key: HV – Highly Viable; V – Viable; M – Maintained; HR – High Risk; Green shaded cells – meets criteria for Highly Viable; Gray shaded cells – does not meet viability criteria (darkest cells are at greatest risk).

	Very Low	Low	Moderate	High
Very Low (<1%)	HV	HV	V	M
Low (1-5%)	V	V	V Lower Main. Snake	M
Moderate (6-25%)	M	M	M	HR
High (>25%)	HR	HR	HR	HR

Limiting Factors. Limiting factors for this species include (NOAA Fisheries 2011):

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

Status of CR Chum Salmon

Columbia River chum salmon are included in the Lower Columbia River recovery plan (NMFS 2013a). Recovery targets for this species focus on improving tributary and estuarine habitat conditions, and re-establishing populations where they may have been extirpated, in order to increase all four viability parameters. Specific recovery goals are to restore Coast and Cascade chum salmon strata to high probability of persistence, and to improve persistence probability of the two Gorge populations by protecting and restoring spawning habitat, side channel, and off channel habitats alcoves, wetlands, floodplains, *etc.* Even with improvements observed during the last five years, the majority of DIPs in this ESU remain at a high or very high-risk category and considerable progress remains to be made to achieve the recovery goals (NWFSC 2015).

Spatial Structure and Diversity. The ESU includes all naturally spawned populations of chum salmon in the Columbia River and its tributaries in Washington and Oregon, as well as four artificial propagation programs (USOFR 2020) (Grays River Hatchery, Big Creek Hatchery, Lewis River Hatchery, and Washougal Hatchery). With the exception of the Grays River stock of fish raised at Big Creek Hatchery, all of the hatchery programs in this ESU use integrated stocks developed to supplement natural production. Ford et al. (2011) concluded that the vast majority (14 out of 17) chum populations remain extirpated or nearly so. The ESU is comprised of three MPGs – the Coastal Range MPG, the Cascade Range MPG, and the Gorge MPG.

In this ESU there have been a number of large-scale efforts to improve habitat accessibility, one of the primary metrics for spatial structure. On the Hood River, Powerdale Dam was removed in 2010 and while this dam previously provided for fish passage, removal of the dam is thought to eliminate passage delays and injuries. Condit Dam, on the White Salmon River, was removed in 2012 and this provided access to previously inaccessible habitat. Both of these dams were above Bonneville Dam, and at present there are few fish available (122 adults in 2014) to colonize these recently accessible habitats.

Abundance and Productivity. Populations in the Coast Range MPG other than the Grays River DIP exist at very low abundances, intermittently observed in very low numbers (<10) in most tributaries other than the Grays River. Two chum spawning aggregates in the mainstem Columbia River just upstream of the I-205 bridge are part of the Washougal River aggregate. In November 2013, two adult chum salmon were observed at the North Fork Dam in the Clackamas River. Chum salmon have also been collected at a number of hatcheries and weirs throughout the Cascade Range MPG, but only in very limited numbers (<10). While the absolute numbers of fish present in many populations are critically low, they may represent important reserves of genetic diversity. Within the Gorge MPG, the Lower Gorge population includes chum salmon returning to Hamilton, Hardy, and Duncan Creeks, and the Ives Island area of the mainstem Columbia River below Bonneville Dam. Other mainstem Columbia River spawning aggregations include Multnomah and Horsetail Creeks on the Oregon shoreline, and in the St. Cloud area along the Washington shoreline. The overall trend since 2000 is negative, with the recent peak in abundance (2010-2011) being considerably lower than the previous peak in 2002. The Upper Gorge population is comprised of a small number (105.6±47.7) that migrate past Bonneville Dam to the upper Gorge population area in most years.

Limiting Factors. Limiting factors for this species are (NMFS 2013a):

- 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

Status of LCR Coho Salmon

This species is included in the Lower Columbia River recovery plan (NMFS 2013a). Specific recovery goals are to improve all four viability parameters to the point that the Coast, Cascade, and Gorge strata achieve high probability of persistence. Protection of existing high functioning habitat and restoration of tributary habitat are noted needs, along with reduction of hatchery and harvest impacts. Large improvements are needed in the persistence probability of most populations of this ESU.

Spatial Structure and Diversity. This ESU includes all naturally spawned populations of coho salmon in the Columbia River and its tributaries in Washington and Oregon, from the mouth of the Columbia River up to and including the Big White Salmon and Hood Rivers, and includes the Willamette River to Willamette Falls, Oregon, as well as multiple artificial propagation programs (USOFR2020). Most of the populations in the ESU contain a substantial number of hatchery-origin spawners. Myers et al. (2006) identified three MPGs (Coastal, Cascade, and Gorge), containing a total of 24 DIPs in the Lower Columbia River coho salmon ESU (Ford 2022).

There have been a number of large-scale efforts to improve accessibility, one of the primary metrics for spatial structure, in this ESU. On the Hood River, Powerdale Dam was removed in 2010 and while this dam previously provided fish passage, removal of the dam is thought to eliminate passage delays and injuries. Condit Dam, on the White Salmon River, was removed in 2011 and this provided access to previously inaccessible habitat. Fish passage operations (trap and haul) were begun on the Lewis River in 2012, reestablishing access to historically-occupied habitat above Swift Dam though, juvenile passage efficiencies are still relatively poor. Presently, the trap and haul program for the Upper Cowlitz, Cispus, and Tilton River populations are the only means by which coho salmon can access spawning habitat for these populations. A trap and haul program also currently maintains access to the North Toutle River above the sediment retention structure with a coho salmon and steelhead being passed above the dam (NWFSC 2015).

Abundance and Productivity. Long-term abundances in the Coast Range Cascade MPG were generally stable. Scappoose Creek is exhibiting a positive abundance trend. Clatskanie River coho salmon population maintains moderate numbers of naturally produced spawners. Washington tributaries indicate the presence of moderate numbers of coho salmon, with total abundances in the hundreds to low thousands of fish. Oregon tributaries have abundances in the hundreds of fish. In the Western Cascade MPG, the Sandy and Clackamas Rivers were the only two populations identified in the original 1996 Status Review that appeared to be self-sustaining natural populations. Natural origin abundances in the Columbia Gorge MPG are low, with hatchery-origin fish contributing a large proportion of the total number of spawners, most notably in the Hood River (Ford 2022). With the exception of the Hood and Big White Salmon Rivers, much of the spawning habitat accessibility is relatively poor. There was no clear trend in the abundance data.

Limiting Factors. Limiting factors for this species include (NMFS 2013a):

- Degraded estuarine and near-shore marine habitat
- Fish passage barriers
- Degraded freshwater habitat: Hatchery-related effects
- Harvest-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

Status of Snake River Sockeye Salmon

Best available information indicates that the species, in this case the Snake River Sockeye Salmon ESU, is at high risk and remains at endangered status. We released a final recovery plan for this species on June 8, 2015 (NMFS 2015b). Overall, the recovery strategy aims to reintroduce and support adaptation of naturally self-sustaining sockeye salmon populations in the Sawtooth Valley lakes.

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

Abundance and Productivity. Adult sockeye salmon returns in the last six years have ranged from a high of 1,579 fish in 2014 (including 453 natural-origin fish) to a low of 257 adults in 2012 (including 52 natural-origin fish). Sockeye salmon returns to Alturas Lake ranged from one fish in 2002 to 14 fish in 2010. No fish returned to Alturas Lake in 2012, 2013, or 2014 (NMFS 2015b). Although total sockeye salmon returns to the Sawtooth Valley in recent years have been high enough to allow for some level of natural spawning in Redfish Lake, the hatchery program remains at its initial phase with a priority on genetic conservation and building sufficient returns to support sustained out-planting and recolonization of the species historic range (NMFS 2015b; NWFSC 2015).

Limiting Factors. The key factor limiting recovery of SR sockeye salmon ESU is survival outside of the Stanley Basin. Portions of the migration corridor in the Salmon River are impaired by reduced water quality and elevated temperatures (Idaho Department of Environmental Quality 2011). The natural hydrological regime in the upper mainstem Salmon River Basin has been altered by water withdrawals. Survival rates from Lower Granite dam to the spawning grounds are low in some years (e.g., average of 31 percent, range of 0-67 percent for 1991-1999) (Keefer et al. 2008). Keefer et al. (2008) conducted a radio tagging study on adult SR sockeye salmon passing upstream from Lower Granite Dam in 2000 and concluded that high in-river mortalities could be explained by "a combination of high migration corridor water temperatures and poor initial fish condition or parasite loads." Keefer et al. (2008) also examined current run timing of SR sockeye salmon versus records from the early 1960s, and concluded that an apparent shift to earlier run timing recently may reflect increased mortalities for later migrating adults. In the Columbia and lower Snake River migration corridor, predation rates on juvenile sockeye salmon are unknown, but terns and cormorants consume 12 percent of all salmon smolts reaching the estuary, and piscivorous fish consume an estimated 8 percent of migrating juvenile salmon (NOAA Fisheries 2011).

Status of Snake River Spring/Summer-run Chinook Salmon

NMFS adopted a final recovery plan for this species in November of 2017 (NMFS 2017a). At least one-half the populations historically present (minimum of two populations) should meet viability criteria (5 percent or less risk of extinction over 100 years). At least one population should be highly viable (less than 1 percent risk of extinction). For MPGs with only one population, this population must be highly viable (less than 1 percent risk of extinction).

Spatial Structure and Diversity This species includes all naturally-spawned populations of spring/summer-run Chinook salmon originating from the mainstem Snake River and the Tucannon River, Grande Ronde River, Imnaha River, and Salmon River subbasins, and from 11 artificial propagation programs (USDC 2014). The IC-TRT recognized 27 extant and four extirpated populations of SR spring/summer-run Chinook salmon, and aggregated these into five MPGs that correspond to ecological subregions (Table 4) (IC-TRT 2003; McClure et al. 2005). All extant populations face a "high" risk of extinction, Ford 2022). Most of the populations also exhibit reduced spatial structure and diversity.

Abundance and Productivity Low abundance and poor productivity remain the primary obstacles to viability for all of the Snake River spring/summer Chinook salmon populations. The latest status review shows that ten Snake River spring/summer Chinook salmon populations increased in both abundance and productivity, seven increased in abundance while their updated productivity estimates decreased, and two populations decreased in abundance and increased in productivity. One population, Loon Creek in the Middle Fork Salmon River MPG, decreased in both abundance and productivity (NWFSC 2015). The relatively low natural production rates and spawning levels below minimum abundance thresholds remain a major obstacle to viability for populations across the ESU. The ability of populations to be self-sustaining in the wild through normal periods of relatively low ocean survival continues to be uncertain.

Table 4. MPGs, populations, and scores for the key elements (A&P, diversity, and SS/D) used to determine current overall viability risk for SR spring/summer-run Chinook salmon (NWFSC 2015). Risk ratings included very low (VL), low (L), moderate (M), high (H), very high (VH), and extirpated (E).

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

Limiting Factors. Limiting factors for this species include (NOAA Fisheries 2011):

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

Status of Lower Columbia River Steelhead

This species is included in the Lower Columbia River recovery plan (NMFS 2013a). For this species, threats in all categories must be reduced, but the most crucial elements are protecting favorable tributary habitat and restoring habitat in the Upper Cowlitz, Cispus, North Fork Toutle, Kalama and Sandy subbasins (for winter steelhead), and the East Fork Lewis, and Hood, subbasins (for summer steelhead). Protection and improvement are also needed among the South Fork Toutle and Clackamas winter steelhead populations.

Spatial Structure and Diversity. The DPS includes all naturally spawned anadromous *O. mykiss* (steelhead) populations below natural and manmade impassable barriers in streams and tributaries to the Columbia River between the Cowlitz and Wind Rivers, Washington (inclusive), and the Willamette and Hood Rivers, Oregon (inclusive), as well as multiple artificial propagation programs (USOFR 2020). There are 4 MPGs comprised of 23 DIPs, including 6 summer-run steelhead populations and 17 winter-run populations that comprise (NWFSC 2015). Summer steelhead return to freshwater long before spawning. Winter steelhead, in contrast, return from the ocean much closer to maturity and spawn within a few weeks. Summer steelhead spawning areas in the Lower Columbia River are found above waterfalls and other features that create seasonal barriers to migration. Where no temporal barriers exist, the winter-run life history dominates.

There have been a number of large-scale efforts to improve accessibility (one of the primary metrics for spatial structure) in this ESU. Trap and haul operations were begun on the Lewis River in 2012 for winter-run steelhead, reestablishing access to historically-occupied habitat above Swift Dam (Ford 2022). In 2014, 1033 adult winter steelhead (integrated program fish) were transported to the upper Lewis River; however, juvenile collection efficiency is still below target levels. In addition, there have been a number of recovery actions throughout the ESU to remove or improve culverts and other small-scale passage barriers. Many of these actions (including the removal of Condit Dam on the White Salmon River) have occurred too recently to be fully evaluated.

Total steelhead hatchery releases in the Lower Columbia River Steelhead DPS have decreased since the last status review, declining from n total (summer and winter run) release of approximately 3.5 million to 3 million from 2008 to 2014. Some populations continue to have relatively high fractions of hatchery-origin spawners, whereas others (e.g., Wind River) have relatively few hatchery origin spawners.

Abundance and Productivity. The Winter-run Western Cascade MPG includes native winter-run steelhead in 14 DIPs from the Cowlitz River to the Washougal River (Ford 2022). Abundances have remained fairly stable and have remained low, averaging in the hundreds of fish. Notable exceptions to this were the Clackamas and Sandy River winter-run steelhead populations, that are exhibiting recent rises in NOR abundance and maintaining low levels of hatchery-origin steelhead on the spawning grounds (Jacobsen et al. 2014). In the Summer-run Cascade MPG, there are four summer-run steelhead populations. Absolute abundances have been in the hundreds of fish. Long- and short-term trends for three DIPs (Kalama, East Fork Lewis and Washougal) are positive; though the 2014 surveys indicate a decrease in abundance for all three. The Winter-run Gorge MPG has three DIPs. In both the Lower and Upper Gorge population surveys for winter steelhead are very limited. Abundance levels have been low, but relatively stable, in the Hood River. In recent years, spawners from the integrated hatchery program have constituted the majority of the naturally spawning fish. The Wind River and Hood River are the two DIPs in the Summer-run Gorge MPG. Hood River summer-run steelhead have not been monitored since the last status review. Adult abundance in the Wind River remains stable, but at a low level (hundreds of fish). The overall status of the MPG is uncertain.

Limiting factors. Limiting factors for this species include (NMFS 2013a):

- 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

Status of Upper Willamette River Steelhead

Upper Willamette River (UWR) steelhead were listed as threatened on January 5, 2006 (71 FR 834). A recovery plan is available for this species (ODFW and NMFS 2011).

Spatial Structure and Diversity. This DPS includes all naturally-spawned anadromous winter-run steelhead populations below natural and manmade impassable barriers in the Willamette River, Oregon, and its tributaries upstream from Willamette Falls to and including the Calapooia River (USDC 2014). Four DIPs of UWR steelhead occur within the DPS (**Table 5**). Historical observations, hatchery records, and genetics suggest that the presence of UWR steelhead in many tributaries on the west side of the upper basin is the result of recent introductions. Nevertheless, the WLC-TRT recognized that although west side UWR steelhead does not represent a historical population, those tributaries may provide juvenile rearing habitat or may be temporarily (for one or more generations) colonized during periods of high abundance. Hatchery summer-run steelhead that are released in the subbasins are from an out-of-basin stock, and are not part of the DPS, nor are stocked summer steelhead that have become established in the McKenzie River (ODFW and NMFS 2011).

There has been no significant change in the UWR steelhead hatchery programs since the previous ESA status review (Jones 2015). The elimination of winter-run hatchery release in the basin reduces hatchery threats, but non-native summer steelhead hatchery releases are still a concern for species diversity because there is some overlap in the spawn timing for summer- and late-winter steelhead. Genetic analysis suggests that there is some level introgression among native late-winter steelhead and summer-run steelhead (Van Doornik et al. 2015), and up to approximately 10 percent of the juvenile steelhead at Willamette Falls and in the Santiam Basin may be hybrids (Johnson et al. 2013). While winter-run steelhead have largely maintained their genetic distinctiveness over time (Van Doornik et al 2015), there are still concerns that hybridization will decrease the overall productivity of the native population. In addition, releases of large numbers of hatchery-origin summer steelhead may temporarily exceed rearing capacities and displace winter-run juvenile steelhead (NWFSC 2015).

Abundance and Productivity. For the UWR steelhead DPS, the declines in abundance noted during the previous review (Ford et al. 2011) continued through the period 2010-2015, and accessibility to historical spawning habitat remains limited, especially in the North Santiam River. Although the recent magnitude of these declines is relatively moderate, Ford (2022) notes that continued declines would be a cause for concern. Much of the accessible habitat in the Molalla, Calapooia, and lower reaches of North and South Santiam rivers is degraded and under continued development pressure. Habitat restoration projects completed in upper Willamette River tributaries are expected to eventually provide benefit to the UWR steelhead DPS, however, the scale of improvements needed is greater than the scale of habitat actions implemented to date (NMFS 2016c). Harvest rates on UWR steelhead have remained stable and relatively low since the last status review, and research impacts remain low. Pinniped predation on UWR steelhead appears to be increasing, for example as in 2014 when 11-18 percent of the total winter steelhead run entering the Willamette River was consumed by pinnipeds at Willamette Falls (Wright et al. 2014). However, we currently are unable to quantify the resulting change in extinction risk due to predation. The impacts that hatcheries and climate change pose to long-term recovery also remain a concern. Overall, the new information considered does not indicate a change in the biological risk category since the last status review (Ford et al 2011), and collective risk to persistence of the DPS has not changed significantly (NWFSC 2015, NMFS 2016c). Recent estimates of escapement in the Molalla River indicate abundance is stable but at a depressed level, and the lack of migration barriers indicates this limitation is likely due to habitat degradation (NWFSC 2015). In the North Santiam, recent radio-tagging studies and counts at Bennett Dam between 2010 and 2014 estimate the average abundance of returning winter-run adults is following a long-term negative trend (Jepson et al 2013, 2014, and 2015). In the South Santiam live counts at Foster Dam indicate a negative trend in abundance from 2010-2014, and redd survey data indicate consistent low numbers of spawners in tributaries (NWFSC 2015). Radio-tagging studies in the Calapooia from 2012-2014 suggest that recent abundances have been depressed but fairly stable, however long-term trends in redd counts conducted since 1985 are generally negative (Jepson et al 2013, 2014, and 2015).

The underlying cause(s) of these declines is not well understood. Returning winter steelhead do not experience the same deleterious water temperatures as the spring-run Chinook salmon. Improvements to Bennett Dam fish passage and operational temperature control at Detroit Dam may be providing some stability in abundance in the North Santiam River DIP. It is unclear if sufficient high-quality habitat is available below Detroit Dam to support the population reaching its VSP recovery goal, or if some form of access to the upper watershed is necessary to sustain a "recovered" population. Similarly, the South Santiam Basin may not be able to achieve its recovery goal status without access to historical spawning and rearing habitat above Green Peter Dam (Quartzville Creek and Middle Santiam River) and/or improved juvenile downstream passage at Foster Dam. Overall, none of the populations in the DPS are meeting their recovery goals (Table 49 in Ford 2022).

Table 5. Scores for the key elements (A&P, diversity, and spatial structure) used to determine current overall viability risk for UWR steelhead (ODFW and NMFS 2011). All populations are in the Western Cascade Range ecological subregion. Risk ratings included very low (VL), low (L), moderate (M), high (H), and very high (VH).

Population (Watershed)	A&P	Diversity	Spatial Structure	Overall Extinction Risk	Current VSP Score Trend
Molalla River	VL	M	M	L	Declining
North Santiam River	VL	M	H	L	Declining
South Santiam River	VL	M	M	L	Declining
Calapooia River	M	M	VH	M	Declining

Limiting Factors. Limiting factors for this species include (ODFW and NMFS 2011):

- Degraded freshwater habitat, including floodplain connectivity and function, channel structure and complexity, incubation gravels, riparian areas, and gravel and large wood recruitment
- Degraded water quality including elevated water temperature and toxins
- Increased disease
- Altered stream flows
- Reduced access to spawning and rearing habitats due to migration barriers and impaired fish 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 races of salmon and steelhead
- Altered population traits due to natural origin fish interbreeding with hatchery origin fish

Status of Southern DPS Green Sturgeon

The southern DPS of green sturgeon was listed as threatened on April 7, 2006 (71 FR 17757). We completed a 5-year review for this DPS in 2015 and recommended the DPS retain its threatened classification. The recovery plan for this DPS was finalized in August, 2018 (NMFS 2018). A key recovery strategy is to reestablish additional spawning areas in currently occupied rivers in California.

Abundance and Productivity. Recent studies are providing preliminary information on the population abundance of Southern DPS green sturgeon. The current estimate of spawning adult abundance is between 824-1,872 individuals (NMFS 2015c). The spawning population of the Southern DPS in the Sacramento River congregates in a limited area of the river compared to potentially available habitat. The reason for this is unknown. This is concerning given that a catastrophic or targeted poaching event impacting just a few holding areas could affect a significant portion of the adult population. No comparable data on holding area occupancy within the Sacramento River were available at the time of the last status review making it difficult to assess whether the current observations reflect an improvement or decline in the species status (NMFS 2015c).

Spatial Structure and Diversity Two DPSs have been defined for green sturgeon (*Acipenser medirostris*), a northern DPS (spawning populations in the Klamath and Rogue rivers) and a southern DPS (spawners in the Sacramento River). Southern green sturgeon includes all naturally-spawned populations of green sturgeon that occur south of the Eel River in Humboldt County, California. Telemetry data and genetic analyses suggest that Southern DPS green sturgeon generally occur from Graves Harbor, Alaska to Monterey Bay, California (Moser and Lindley 2007; Lindley et al. 2008, 2011) and, within this range, most frequently occur in coastal waters of Washington, Oregon, and Vancouver Island and near San Francisco and Monterey bays (Huff et al. 2012). 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 m (Erickson and Hightower 2007).

Limiting Factors. The principal factor for the decline of southern green sturgeon is the reduction of its spawning area to a single known population limited to a small portion of the Sacramento River. It is currently at risk of extinction primarily because of elimination of freshwater spawning habitat, degradation of freshwater and estuarine habitat quality, water diversions, fishing, and other causes (USDC 2010). Adequate water flow and temperature are issues of concern. Water diversions pose an unknown but potentially serious threat within the Sacramento and Feather Rivers and the Sacramento River Delta. Poaching also poses an unknown but potentially serious threat because of high demand for sturgeon caviar. The effects of contaminants and nonnative species are also unknown but potentially serious. As mentioned above, retention of green sturgeon in both recreational and commercial fisheries is now prohibited within the western states, but the effect of capture/release in these fisheries is unknown. There is evidence of fish being retained illegally, although the magnitude of this activity likely is small (NOAA Fisheries 2011).

Status of Humpback Whales

Humpback whales were listed as endangered under the Endangered Species Conservation Act in June 1970 (35 FR 18319), and remained on the list of threatened and endangered species after the passage of the ESA in 1973 (35 FR 8491). A recovery plan for humpbacks was issued in November 1991 (NMFS 1991). On September 8, 2016, NMFS published a final rule to divide the globally listed endangered humpback whale into 14 DPSs and place four DPSs (Western North Pacific, Arabian Sea, Cape Verde/Northwest Africa, and Central America) as endangered and one (the Mexico DPS) as threatened (81 FR 62259). Only Central America and Mexico DPSs occur within the waters of the Pacific Northwest. No Critical Habitat has been designated for humpback whales.

<u>Mexico DPS</u>
This DPS is threatened. A recovery strategy under SARA was published in 2013 (Fisheries and Oceans Canada 2013). The two goals of this recovery strategy are: In the short term, to maintain, at a minimum, the current abundance of humpback whales in British Columbia (using best estimate of 2,145 animals (95 percent CI = 1,970-2,331 as presented in Ford et al. 2009)); and, in the longer-term, to observe continued growth of the population and expansion into suitable habitats throughout British Columbia. To meet these goals, threat and population monitoring, research, management, protection and enforcement, stewardship, outreach and education activities were recommended.

<u>Spatial Structure and Diversity.</u> The Mexico DPS consists of whales that breed along the Pacific coast of mainland Mexico, and the Revillagigedos Islands and transit through the Baja California Peninsula coast. The Mexico DPS feeds across a broad geographic range from California to the Aleutian Islands, with concentrations in California-Oregon, northern Washington-southern British Columbia, northern and western Gulf of Alaska and Bering Sea feeding grounds.
Abundance and Trends for the Mexico DPS

<u>Abundance and Productivity</u> The preliminary estimate of abundance of the Mexico DPS that informed our proposed rule was 6,000-7,000 from the SPLASH project (Calambokidis et al. 2008), or higher (Barlow et al. 2011). There were no estimates of precision associated with that estimate, so there was considerable uncertainty about the actual population size. However, the BRT was confident that the population was likely to be much greater than 2,000 in total size (above the BRT threshold for a population to be not at risk due to low abundance). Estimates of population growth trends do not exist for the Mexico DPS by itself. Given evidence of population growth throughout most of the primary feeding areas of the Mexico DPS (California/Oregon – Calambokidis et al. 2008), Gulf of Alaska from the Shumagins to Kodiak (Zerbini et al. 2006a), it was considered unlikely this DPS was declining, but the BRT noted that a reliable, quantitative estimate of the population growth rate for this DPS was not available. The abundance estimate for the Mexico DPS is 3,264 individuals, and the population trend is unknown.

<u>Limiting Factors</u> Vessel collisions and entanglement in fishing gear pose the greatest threat to this DPS.

Central America DPS

Spatial Structure and Diversity. The Central America DPS is composed of whales that breed along the Pacific coast of Costa Rica, Panama, Guatemala, El Salvador, Honduras and Nicaragua. Whales from this breeding ground feed almost exclusively offshore of California and Oregon in the eastern Pacific, with only a few individuals identified at the northern Washington-southern British Columbia feeding grounds.

Abundance and Productivity A preliminary estimate of abundance of the Central America population was ~500 from the SPLASH project (Calambokidis et al. 2008), or ~600 based on the reanalysis by Barlow et al. (2011). There were no estimates of precision associated with these estimates, so there was considerable uncertainty about the actual population size. Therefore, the actual population size could have been somewhat larger or smaller than 500-600, but the BRT considered it very unlikely to be as large as 2,000 or more. The size of this DPS was relatively low compared to most other North Pacific breeding populations (Calambokidis et al.2008) and within the range of population sizes considered by the BRT to be at risk based on low abundance. The trend of the Central America DPS was considered unknown. The abundance estimate of the Central America DPS is 411 individuals, with unknown population trend.

Limiting Factors Vessel collisions and entanglement in fishing gear pose the greatest threat to this DPS.

2.2.2 Status of the Critical Habitat

This section examines the status of designated critical habitat affected by the proposed action by examining the condition and trends of essential physical and biological features throughout the designated areas. These features are essential to the conservation of the 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).

Salmon and Steelhead

For salmon and steelhead, NMFS ranked watersheds within designated critical habitat at the scale of the fifth-field hydrologic unit code (HUC_5) in terms of the conservation value they provide to each listed species they support.[1] The conservation rankings are high, medium, or low. To determine the conservation value of each watershed to species viability, NMFS's critical habitat analytical review teams (CHARTs) evaluated the quantity and quality of habitat features (for example, spawning gravels, wood and water condition, side channels), 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 (NOAA Fisheries 2005). Thus, even a location that has poor quality of habitat could be ranked with a high conservation value if it were essential due to factors such as limited availability (*e.g.*, one of a very few spawning areas), a unique contribution of the population it served (*e.g.*, a population at the extreme end of geographic

[1] The conservation value of a site depends upon "(1) the importance of the populations associated with a site to the ESU [or DPS] conservation, and (2) the contribution of that site to the conservation of the population through demonstrated or potential productivity of the area" NOAA Fisheries (2005). Assessment of NOAA Fisheries' critical habitat analytical review teams for 12 evolutionarily significant units of West Coast salmon and steelhead. National Marine Fisheries Service, Protected Resources Division. Portland, Oregon..

distribution), or if it serves another important role (*e.g.*, obligate area for migration to upstream spawning areas). The primary constituent elements or essential features of critical habitat for salmon and steelhead are identified in Table 6 and Table 7.

Table 6. Primary constituent elements (PCEs) of critical habitats designated for ESA-listed salmon and steelhead species considered in the opinion (except SR spring/summer-run Chinook salmon, SR fall-run Chinook salmon, SR sockeye salmon, and SONCC coho salmon), and corresponding species life history events.

Primary Constituent Elements Site Type	Primary Constituent Elements Site Attribute	Species Life History Event
Freshwater spawning	Substrate Water quality Water quantity	Adult spawning Embryo incubation Alevin growth and development
Freshwater rearing	Floodplain connectivity Forage Natural cover Water quality Water quantity	Fry emergence from gravel Fry/parr/smolt growth and development
Freshwater migration	Free of artificial obstruction Natural cover Water quality Water quantity	Adult sexual maturation Adult upstream migration and holding Kelt (steelhead) seaward migration Fry/parr/smolt growth, development, and seaward migration
Estuarine areas	Forage Free of artificial obstruction Natural cover Salinity Water quality Water quantity	Adult sexual maturation and "reverse smoltification" Adult upstream migration and holding Kelt (steelhead) seaward migration Fry/parr/smolt growth, development, and seaward migration
Nearshore marine areas	Forage Free of artificial obstruction Natural cover Water quantity Water quality	Adult growth and sexual maturation Adult spawning migration Nearshore juvenile rearing

Table 7. Essential features of critical habitats designated for SR spring/summer-run Chinook salmon, SR fall-run Chinook salmon, SR sockeye salmon, SONCC coho salmon, and corresponding species life history events.

Essential Features Site	Essential Features Site Attribute	Species Life History Event
Spawning and juvenile rearing areas	Access (sockeye) Cover/shelter Food (juvenile rearing) Riparian vegetation Space (Chinook, coho) Spawning gravel Water quality Water temp (sockeye) Water quantity	Adult spawning Embryo incubation Alevin growth and development Fry emergence from gravel Fry/parr/smolt growth and development
Adult and juvenile migration corridors	Cover/shelter Food (juvenile) Riparian vegetation Safe passage Space Substrate Water quality Water quantity Water temperature Water velocity	Adult sexual maturation Adult upstream migration and holding Kelt (steelhead) seaward migration Fry/parr/smolt growth, development, and seaward migration
Areas for growth and development to adulthood	Ocean areas – not identified	Nearshore juvenile rearing Subadult rearing Adult growth and sexual maturation Adult spawning migration

CHART Salmon and Steelhead Critical Habitat Assessments

The CHART for each recovery domain assessed biological information pertaining to occupied by listed salmon and steelhead, determine whether those areas contained PCEs essential for the conservation of those species and whether unoccupied areas existed within the historical range of the listed salmon and steelhead that are also essential for conservation. The CHARTs assigned a 0 to 3 point score for the PCEs in each HUC_5 watershed for:

Factor 1. Quantity,
Factor 2. Quality – Current Condition,
Factor 3. Quality – Potential Condition,
Factor 4. Support of Rarity Importance,
Factor 5. Support of Abundant Populations, and
Factor 6. Support of Spawning/Rearing.

Thus, the quality of habitat in a given watershed was characterized by the scores for Factor 2 (quality – current condition), which considers the existing condition of the quality of PCEs in the HUC_5 watershed; and Factor 3 (quality – potential condition), which considers the likelihood of achieving PCE potential in the HUC_5 watershed, either naturally or through active conservation/restoration, given known limiting factors, likely biophysical responses, and feasibility.

Willamette-Lower Columbia Recovery Domain

Critical habitat was designated in the WLC recovery domain for UWR Chinook salmon, LCR Chinook salmon, LCR steelhead, UWR steelhead, CR chum salmon, southern green sturgeon, and eulachon, and has been proposed for LCR coho salmon. In addition to the Willamette and Columbia River mainstems, important tributaries on the Oregon side of the WLC include Youngs Bay, Big Creek, Clatskanie River, and Scappoose River in the Oregon Coast subbasin; Hood River in the Gorge; and the Sandy, Clackamas, Molalla, North and South Santiam, Calapooia, McKenzie, and Middle Fork Willamette rivers in the West Cascades subbasin.

Land management activities have severely degraded stream habitat conditions in the Willamette River mainstem above Willamette Falls and in associated subbasins. In the Willamette River mainstem and lower sub-basin mainstem reaches, high density urban development and widespread agricultural effects have reduced aquatic and riparian habitat quality and complexity, and altered sediment and water quality and quantity, and watershed processes. The Willamette River, once a highly braided river system, has been dramatically simplified through channelization, dredging, and other activities that have reduced rearing habitat by as much as 75 percent. In addition, the construction of 37 dams in the basin blocked access to more than 435 miles of stream and river spawning habitat. The dams alter the temperature regime of the Willamette River and its tributaries, affecting the timing and development of naturally-spawned eggs and fry. Logging in the Cascade and Coast Ranges, and agriculture, urbanization, and gravel mining on valley floors have contributed to increased erosion and sediment loads throughout the WLC domain.

The mainstem Willamette River has been channelized and stripped of large wood. Development began to encroach on the riparian forest beginning in the 1870s (Sedell and Froggatt 1984). The total area of river channels and islands in the Willamette River decreased from 41,000 to 23,000 acres, and the total length of all channels decreased from 355 miles to 264 miles, between 1895 and 1995 (Gregory, Ashkenas et al. 2002). They noted that the lower reach, from the mouth of the river to Newberg (RM 50), is confined within a basaltic trench, and that due to this geomorphic constraint, less channel area has been lost than in upstream areas. The middle reach from Newberg to Albany (RM 50 to 120) incurred losses of 12 percent of primary channel area, 16 percent of side channels, 33 percent of alcoves, and 9 percent of island area. Even greater changes occurred in the upper reach, from Albany to Eugene (RM 187). There, approximately 40 percent of both channel length and channel area were lost, along with 21 percent of the primary channel, 41 percent of side channels, 74 percent of alcoves, and 80 percent of island areas.

The banks of the Willamette River have more than 96 miles of revetments; approximately half were constructed by the USACE. Generally, the revetments were placed in the vicinity of roads or on the outside bank of river bends, so that while only 26 percent of the total length is revetted, 65 percent of the meander bends are revetted (Gregory, Ashkenas et al. 2002). The majority of dynamic sections have been armored, reducing adjustments in channel bed and sediment storage by the river, and thereby diminishing both the complexity and productivity of aquatic habitats (Gregory, Ashkenas et al. 2002).

Riparian forests have diminished considerably in the lower reaches of the Willamette River (Gregory, Ashkenas et al. 2002). Sedell and Froggatt (1984) noted that agriculture and cutting of streamside trees were major agents of change for riparian vegetation, along with snagging of large wood in the channel. The reduced shoreline, fewer and smaller snags, and reduced riparian forest comprise large functional losses to the river, reducing structural features, inputs of wood and litter, shade, entrained allochthonous materials, and flood flow filtering capacity. Extensive changes began before the major dams were built, with navigational and agricultural demands dominating the early use of the river. The once expansive forests of the Willamette River floodplain provided valuable nutrients and organic matter during flood pulses, food sources for macroinvertebrates, and slow-water refugia for fish during flood events. These forests also cooled river temperatures as the river flowed through its many channels.

Hyporheic flow in the Willamette River has been examined through discharge measurements and is significant in some areas, particularly those with gravel deposits (Wentz, Bonn et al. 1998, Fernald, Wigington et al. 2001). The loss of channel complexity and meandering that fosters creations of gravel deposits decreases the potential for hyporheic flows, as does gravel mining. Hyporheic flow processes water and affects its quality on reemerging into the main channel, stabilizing variations in physical and chemical water characteristics. Hyporheic flow is important for ecological functions, some aspects of water quality (such as temperature and dissolved oxygen), and some benthic invertebrate life stages. Alcove habitat, which has been limited by channelization, combines low hydraulic stress and high food availability with the potential for hyporheic flows across the steep hydraulic gradients in the gravel separating them from the main channel (Fernald, Wigington et al. 2001).

On the mainstem of the Columbia River, hydropower projects, including the Federal Columbia River Hydropower System (FCRPS), have significantly degraded salmon and steelhead habitats (Bottom, Simenstad et al. 2005, Fresh, Casillas et al. 2005, NMFS 2011, NMFS 2013). The series of dams and reservoirs that make up the FCRPS block an estimated 12 million cubic yards of debris and sediment that would otherwise naturally flow down the Columbia River and replenish shorelines along the Washington and Oregon coasts.

Industrial harbor and port development are also significant influences on the Lower Willamette and Lower Columbia rivers (Bottom, Simenstad et al. 2005, Fresh, Casillas et al. 2005, NMFS 2011, NMFS 2013). Since 1878, 100 miles of river channel within the mainstem Columbia River, its estuary, and Oregon’s Willamette River have been dredged as a navigation channel by the USACE. Originally dredged to a 20-foot minimum depth, the Federal navigation channel of the Lower Columbia River is now maintained at a depth of 43 feet and a width of 600 feet. The Lower Columbia River supports five ports on the Washington State side: Kalama, Longview, Skamania County, Woodland, and Vancouver. In addition to loss of riparian habitat, and disruption of benthic habitat due to dredging, high levels of several sediment chemicals ― such as arsenic and polycyclic aromatic hydrocarbons ― have been identified in Lower Columbia River watersheds in the vicinity of the ports and associated industrial facilities.

The most extensive urban development in the Lower Columbia River subbasin has occurred in the Portland/Vancouver area. Outside of this major urban area, the majority of residences and businesses rely on septic systems. Common water quality issues with urban development and residential septic systems include higher water temperatures, lowered dissolved oxygen, increased fecal coliform bacteria, and increased chemicals associated with pesticides and urban runoff.

The Columbia River estuary has lost a significant amount of the tidal marsh and tidal swamp habitats that are critical to juvenile salmon and steelhead, particularly small or ocean-type species (Bottom, Simenstad et al. 2005, Fresh, Casillas et al. 2005, NMFS 2011, NMFS 2013). Edges of marsh areas provide sheltered habitats for juvenile salmon and steelhead where food, in the form of amphipods or other small invertebrates which feed on marsh detritus, is plentiful, and larger predatory fish can be avoided. Historically, floodwaters of the Columbia River inundated the margins and floodplains along the estuary, allowing juvenile salmon and steelhead access to a wide expanse of low-velocity marshland and tidal channel habitats. In general, the riverbanks were gently sloping, with riparian and wetland vegetation at the higher elevations of the river floodplain becoming habitat for salmon and steelhead during flooding river discharges or flood tides. Sherwood et al. (1990) estimated that the Columbia River estuary lost 20,000 acres of tidal swamps, 10,000 acres of tidal marshes, and 3,000 acres of tidal flats between 1870 and 1970. This study further estimated an 80 percent reduction in emergent vegetation production and a 15 percent decline in benthic algal production.

Habitat and food-web changes within the estuary, and other factors affecting salmon population structure and life histories, have altered the estuary's capacity to support juvenile salmon (Bottom, Simenstad et al. 2005, Fresh, Casillas et al. 2005, NMFS 2011, NMFS 2013). Diking and filling have reduced the tidal prism and eliminated emergent and forested wetlands and floodplain habitats. These changes have likely reduced the estuary's salmon-rearing capacity. Moreover, water and sediment in the Lower Columbia River and its tributaries have toxins that are harmful to aquatic resources (Lower Columbia River Estuary Partnership 2007). Contaminants of concern include dioxins and furans, heavy metals, polychlorinated biphenyls (PCBs) and organochlorine pesticides such as DDT. Simplification of the population structure and life-history diversity of salmon possibly is yet another important factor affecting juvenile salmon viability. Restoration of estuarine habitats, particularly diked emergent and forested wetlands, reduction of avian predation by terns, and flow manipulations to restore historical flow patterns have likely begun to enhance the estuary's capacity to support salmon, although historical changes in population structure and salmon life histories may prevent salmon from making full use of estuarine habitats.

The CHART for the WLC recovery domain determined that most HUC_5 watersheds with PCEs for salmon or steelhead are in fair-to-poor or fair-to-good condition (NOAA Fisheries 2005). However, most of these watersheds have some or a high potential for improvement. Only watersheds in the upper McKenzie River and its tributaries are in good to excellent condition with no potential for improvement (Table 8).

Table 8. **Willamette-Lower Columbia Recovery Domain:** Current and potential quality of HUC_5 watersheds identified as supporting historically independent populations of ESA-listed Chinook salmon (CK), chum salmon (CM), and steelhead (ST) (NOAA Fisheries 2005).[2] Watersheds are ranked primarily by "current quality" and secondly by their "potential for restoration."

Current PCE Condition	Potential PCE Condition
3 = good to excellent	3 = highly functioning, at historical potential
2 = fair to good	2 = high potential for improvement
1 = fair to poor	1 = some potential for improvement
0 = poor	0 = little or no potential for improvement

Watershed Name(s) and HUC_5 Code(s)	Listed Species	Current Quality	Restoration Potential
Columbia Gorge #1707010xxx			
Wind River (511)	CK/ST	2/2	2/2
East Fork Hood (506), & Upper (404) & Lower Cispus (405) rivers	CK/ST	2/2	2/2
Plympton Creek (306)	CK	2	2
Little White Salmon River (510)	CK	2	0
Grays Creek (512) & Eagle Creek (513)	CK/CM/ST	2/1/2	1/1/2
White Salmon River (509)	CK/CM	2/1	1/2
West Fork Hood River (507)	CK/ST	1/2	2/2
Hood River (508)	CK/ST	1/1	2/2
Unoccupied habitat: Wind River (511)	Chum conservation value "Possibly High"		
Cascade and Coast Range #1708000xxx			
Lower Gorge Tributaries (107)	CK/CM/ST	2/2/2	2/3/2
Lower Lewis (206) & North Fork Toutle (504) rivers	CK/CM/ST	1/3/1	2/1/2
Salmon (101), Zigzag (102), & Upper Sandy (103) rivers	CK/ST	2/2	2/2
Big Creek (602)	CK/CM	2/2	2/2
Coweeman River (508)	CK/CM/ST	2/2/1	2/1/2
Kalama River (301)	CK/CM/ST	1/2/2	2/1/2
Cowlitz Headwaters (401)	CK/ST	2/2	1/1
Skamokawa/Elochoman (305)	CK/CM	2/1	2
Salmon Creek (109)	CK/CM/ST	1/2/1	2/3/2
Green (505) & South Fork Toutle (506) rivers	CK/CM/ST	1/1/2	2/1/2
Jackson Prairie (503) & East Willapa (507)	CK/CM/ST	1/2/1	1/1/2
Grays Bay (603)	CK/CM	1/2	2/3
Upper Middle Fork Willamette River (101)	CK	2	1
Germany/Abernathy creeks (304)	CK/CM	1/2	2
Mid-Sandy (104), Bull Run (105), & Lower Sandy (108) rivers	CK/ST	1/1	2/2
Washougal (106) & East Fork Lewis (205) rivers	CK/CM/ST	1/1/1	2/1/2
Upper Cowlitz (402) & Tilton rivers (501) & Cowlitz Valley Frontal (403)	CK/ST	1/1	2/1
Clatskanie (303) & Young rivers (601)	CK	1	2

[2] On January 14, 2013, NMFS published a proposed rule for the designation of critical habitat for LCR coho salmon and PS steelhead USDC (2013). "Endangered and threatened species; Designation of critical habitat for Lower Columbia River coho salmon and Puget Sound steelhead; Proposed rule." U.S Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service. Federal Register **78**(9): 2726-2796.. A draft biological report, which includes a CHART assessment for PS steelhead, was also completed NMFS (2012). Designation of critical habitat for Lower Columbia River coho salmon and Puget Sound steelhead, Draft biological report. National Marine Fisheries Service, Protected Resources Division. Portland, Oregon.. Habitat quality assessments for LCR coho salmon are out for review; therefore, they are not included on this table.

Current PCE Condition	Potential PCE Condition
3 = good to excellent	3 = highly functioning, at historical potential
2 = fair to good	2 = high potential for improvement
1 = fair to poor	1 = some potential for improvement
0 = poor	0 = little or no potential for improvement

Watershed Name(s) and HUC_5 Code(s)	Listed Species	Current Quality	Restoration Potential
Rifle Reservoir (502)	CK/ST	1	1
Beaver Creek (302)	CK	0	1
Unoccupied Habitat: Upper Lewis (201) & Muddy (202) rivers; Swift (203) & Yale (204) reservoirs	CK & ST Conservation Value "Possibly High"		
Willamette River #1709000xxx			
Upper (401) & South Fork (403) McKenzie rivers; Horse Creek (402); & McKenzie River/Quartz Creek (405)	CK	3	3
Lower McKenzie River (407)	CK	2	3
South Santiam River (606)	CK/ST	2/2	1/3
South Santiam River/Foster Reservoir (607)	CK/ST	2/2	1/2
North Fork of Middle Fork Willamette (106) & Blue (404) rivers	CK	2	1
Upper South Yamhill River (801)	ST	2	1
Little North Santiam River (505)	CK/ST	1/2	3/3
Upper Molalla River (905)	CK/ST	1/2	1/1
Abernethy Creek (704)	CK/ST	1/1	1/2
Luckiamute River (306) & Yamhill (807) Lower Molalla (906) rivers; Middle (504) & Lower (506) North Santiam rivers; Hamilton Creek/South Santiam River (601); Wiley Creek (608); Mill Creek/Willamette River (701); & Willamette River/Chehalem Creek (703); Lower South (804) & North (806) Yamhill rivers; & Salt Creek/South Yamhill River (805)	CK/ST	1	1
Hills (102) & Salmon (104) creeks; Salt Creek/Willamette River (103), Hills Creek Reservoir (105), Middle Fork Willamette/Lookout Point (107); Little Fall (108) & Fall (109) creeks; Lower Middle Fork of Willamette (110), Long Tom (301), Marys (305) & Mohawk (406) rivers	CK	1	1
Willamina Creek (802) & Mill Creek/South Yamhill River (803)	ST	1	1
Calapooia River (303); Oak (304) Crabtree (602), Thomas (603) & Rickreall (702) creeks; Abiqua (901), Butte (902) & Rock (903) creeks/Pudding River; & Senecal Creek/Mill Creek (904)	CK/ST	1/1	0/1
Row River (201), Mosby (202) & Muddy (302) creeks, Upper (203) & Lower (205) Coast Fork Willamette River	CK	1	0
Unoccupied habitat in North Santiam (501) & North Fork Breitenbush (502) rivers; Quartzville Creek (604) and Middle Santiam River (605)	CK & ST Conservation Value "Possibly High"		
Unoccupied habitat in Detroit Reservoir/Blowout Divide Creek (503)	Conservation Value: CK "Possibly Medium"; ST Possibly High"		
Lower Willamette #1709001xxx			
Collawash (101), Upper Clackamas (102), & Oak Grove Fork (103) Clackamas rivers	CK/ST	2/2	3/2
Middle Clackamas River (104)	CK/ST	2/1	3/2
Eagle Creek (105)	CK/ST	2/2	1/2
Gales Creek (002)	ST	2	1
Lower Clackamas River (106) & Scappoose Creek (202)	CK/ST	1	2
Dairy (001) & Scoggins (003) creeks; Rock Creek/Tualatin River (004); & Tualatin River (005)	ST	1	1

Current PCE Condition	Potential PCE Condition
3 = good to excellent	3 = highly functioning, at historical potential
2 = fair to good	2 = high potential for improvement
1 = fair to poor	1 = some potential for improvement
0 = poor	0 = little or no potential for improvement

Watershed Name(s) and HUC_5 Code(s)	Listed Species	Current Quality	Restoration Potential
Johnson Creek (201)	CK/ST	0/1	2/2
Lower Willamette/Columbia Slough (203)	CK/ST	0	2

Interior Columbia Recovery Domain

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

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

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

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

A series of large regulating dams on the middle and upper Deschutes River affect flow and block access to upstream habitat, and have extirpated one or more populations from the Cascades Eastern Slope major population. Also, operation and maintenance of large water reclamation systems such as the Umatilla Basin and Yakima Projects have significantly modified flow regimes and degraded water quality and physical habitat in this domain.

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

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

The IC recovery domain is a very large and diverse area. The CHART determined that few watersheds with PCEs for Chinook salmon or steelhead are in good to excellent condition with no potential for improvement. Overall, most IC recovery domain watersheds are in fair-to-poor or fair-to-good condition. However, most of these watersheds have some or high potential for improvement. In Washington, the Upper Methow, Lost, White, and Chiwawa watersheds are in good-to-excellent condition with no potential for improvement. In Oregon, only the Lower Deschutes, Minam, Wenaha, and Upper and Lower Imnaha Rivers HUC_5 watersheds are in good-to-excellent condition with no potential for improvement. In Idaho, a number of watersheds with PCEs for steelhead (Upper Middle Salmon, Upper Salmon/Pahsimeroi, Middle Fork Salmon, Little Salmon, Selway, and Lochsa rivers) are in good-to-excellent condition with no potential for improvement. Additionally, several Lower Snake River HUC_5watersheds in the Hells Canyon area, straddling Oregon and Idaho, are in good-to-excellent condition with no potential for improvement (Table 9).

Table 9. **Interior Columbia Recovery Domain:** Current and potential quality of HUC_5 watersheds identified as supporting historically independent populations of ESA-listed Chinook salmon (CK) and steelhead (ST) (NOAA Fisheries 2005). Watersheds are ranked primarily by "current quality" and secondly by their "potential for restoration."

Current PCE Condition	Potential PCE Condition
3 = good to excellent	3 = highly functioning, at historical potential
2 = fair to good	2 = high potential for improvement
1 = fair to poor	1 = some potential for improvement
0 = poor	0 = little or no potential for improvement

Watershed Name and HUC_5 Code(s)	Listed Species	Current Quality	Restoration Potential
Upper Columbia # 1702000xxx			
White (101), Chiwawa (102), Lost (801) & Upper Methow (802) rivers	CK/ST	3	3
Upper Chewuch (803) & Twisp rivers (805)	CK/ST	3	2
Lower Chewuch River (804); Middle (806) & Lower (807) Methow rivers	CK/ST	2	2
Salmon Creek (603) & Okanogan River/Omak Creek (604)	ST	2	2
Upper Columbia/Swamp Creek (505)	CK/ST	2	1
Foster Creek (503) & Jordan/Tumwater (504)	CK/ST	1	1
Upper (601) & Lower (602) Okanogan River; Okanogan River/Bonaparte Creek (605); Lower Similkameen River (704); & Lower Lake Chelan (903)	ST	1	1
Unoccupied habitat in Sinlahekin Creek (703)	ST Conservation Value "Possibly High"		
Upper Columbia #1702001xxx			
Entiat River (001); Nason/Tumwater (103); & Lower Wenatchee River (105)	CK/ST	2	2
Lake Entiat (002)	CK/ST	2	1
Columbia River/Lynch Coulee (003); Sand Hollow (004); Yakima/Hansen Creek (604), Middle Columbia/Priest Rapids (605), & Columbia River/Zintel Canyon (606)	ST	2	1
Icicle/Chumstick (104)	CK/ST	1	2
Lower Crab Creek (509)	ST	1	2
Rattlesnake Creek (204)	ST	0	1
Yakima #1703000xxx			
Upper (101) & Middle (102) Yakima rivers; Teanaway (103) & Little Naches (201) rivers; Naches River/Rattlesnake Creek (202); & Ahtanum (301) & Upper Toppenish (303) & Satus (305) creeks	ST	2	2
Umtanum/Wenas (104); Naches River/Tieton River (203); Upper Lower Yakima River (302); & Lower Toppenish Creek (304)	ST	1	2
Yakima River/Spring Creek (306)	ST	1	1
Lower Snake River #1706010xxx			
Snake River/Granite (101), Getta (102), & Divide (104) creeks; Upper (201) & Lower (205) Imnaha River; Snake River/Rogersburg (301); Minam (505) & Wenaha (603) rivers	ST	3	3
Grande Ronde River/Rondowa (601)	ST	3	2
Big (203) & Little (204) Sheep creeks; Asotin River (302); Catherine Creek (405); Lostine River (502); Bear Creek (504); & Upper (706) & Lower (707) Tucannon River	ST	2	3

Current PCE Condition	Potential PCE Condition
3 = good to excellent	3 = highly functioning, at historical potential
2 = fair to good	2 = high potential for improvement
1 = fair to poor	1 = some potential for improvement
0 = poor	0 = little or no potential for improvement

Watershed Name and HUC_5 Code(s)	Listed Species	Current Quality	Restoration Potential
Middle Imnaha River (202); Snake River/Captain John Creek (303); Upper Grande Ronde River (401); Meadow (402); Beaver (403); Indian (409), Lookingglass (410) & Cabin (411) creeks; Lower Wallowa River (506); Mud (602), Chesnimnus (604) & Upper Joseph (605) creeks	ST	2	2
Ladd Creek (406); Phillips/Willow Creek (408); Upper (501) & Middle (503) Wallowa rivers; & Lower Grande Ronde River/Menatche Creek (607)	ST	1	3
Five Points (404); Lower Joseph (606) & Deadman (703) creeks	ST	1	2
Tucannon/Alpowa Creek (701)	ST	1	1
Mill Creek (407)	ST	0	3
Pataha Creek (705)	ST	0	2
Snake River/Steptoe Canyon (702) & Penawawa Creek (708)	ST	0	1
Flat Creek (704) & Lower Palouse River (808)	ST	0	0
Upper Salmon and Pahsimeroi #1706020xxx			
Germania (111) & Warm Springs (114) creeks; Lower Pahsimeroi River (201); Alturas Lake (120), Redfish Lake (121), Upper Valley (123) & West Fork Yankee (126) creeks	ST	3	3
Basin Creek (124)	ST	3	2
Salmon River/Challis (101); East Fork Salmon River/McDonald Creek (105); Herd Creek (108); Upper East Fork Salmon River (110); Salmon River/Big Casino (115), Fisher (117) & Fourth of July (118) creeks; Upper Salmon River (119); Valley Creek/Iron Creek (122); & Morgan Creek (132)	ST	2	3
Salmon River/Bayhorse Creek (104); Salmon River/Slate Creek (113); Upper Yankee Fork (127) & Squaw Creek (128); Pahsimeroi River/Falls Creek (202)	ST	2	2
Yankee Fork/Jordan Creek (125)	ST	1	3
Salmon River/Kinnikinnick Creek (112); Garden Creek (129); Challis Creek/Mill Creek (130); & Patterson Creek (203)	ST	1	2
Road Creek (107)	ST	1	1
Unoccupied habitat in Hawley (410), Eighteenmile (411) & Big Timber (413) creeks	Conservation Value for ST "Possibly High"		
Middle Salmon, Panther and Lemhi #1706020xxx			
Salmon River/Colson (301), Pine (303) & Moose (305) creeks; Indian (304) & Carmen (308) creeks, North Fork Salmon River (306); & Texas Creek (412)	ST	3	3
Deep Creek (318)	ST	3	2
Salmon River/Cow Creek (312) & Hat (313), Iron (314), Upper Panther (315), Moyer (316) & Woodtick (317) creeks; Lemhi River/Whimpey Creek (402); Hayden (414), Big Eight Mile (408), & Canyon (408) creeks	ST	2	3
Salmon River/Tower (307) & Twelvemile (311) creeks; Lemhi River/Kenney Creek (403); Lemhi River/McDevitt (405), Lemhi River/Yearian Creek (406); & Peterson Creek (407)	ST	2	2

Current PCE Condition	Potential PCE Condition
3 = good to excellent	3 = highly functioning, at historical potential
2 = fair to good	2 = high potential for improvement
1 = fair to poor	1 = some potential for improvement
0 = poor	0 = little or no potential for improvement

Watershed Name and HUC_5 Code(s)	Listed Species	Current Quality	Restoration Potential
Owl (302) & Napias (319) creeks	ST	2	1
Salmon River/Jesse Creek (309); Panther Creek/Trail Creek (322); & Lemhi River/Bohannon Creek (401)	ST	1	3
Salmon River/Williams Creek (310)	ST	1	2
Agency Creek (404)	ST	1	1
Panther Creek/Spring Creek (320) & Clear Creek (323)	ST	0	3
Big Deer Creek (321)	ST	0	1
Mid-Salmon-Chamberlain, South Fork, Lower, and Middle Fork Salmon #1706020xxx			
Lower (501), Upper (503) & Little (504) Loon creeks; Warm Springs (502); Rapid River (505); Middle Fork Salmon River/Soldier (507) & Lower Marble Creek (513); & Sulphur (509), Pistol (510), Indian (511) & Upper Marble (512) creeks; Lower Middle Fork Salmon River (601); Wilson (602), Upper Camas (604), Rush (610), Monumental (611), Beaver (614), Big Ramey (615) & Lower Big (617) creeks; Middle Fork Salmon River/Brush (603) & Sheep (609) creeks; Big Creek/Little Marble (612); Crooked (616), Sheep (704), Bargamin (709), Sabe (711), Horse (714), Cottonwood (716) & Upper Chamberlain Creek (718); Salmon River/Hot Springs (712); Salmon River/Kitchen Creek (715); Lower Chamberlain/McCalla Creek (717); & Slate Creek (911)	ST	3	3
Marsh (506); Bear Valley (508) Yellow Jacket (604); West Fork Camas (607) & Lower Camas (608) creeks; & Salmon River/Disappointment Creek (713) & White Bird Creek (908)	ST	2	3
Upper Big Creek (613); Salmon River/Fall (701), California (703), Trout (708), Crooked (705) & Warren (719) creeks; Lower South Fork Salmon River (801); South Fork Salmon River/Cabin (809), Blackmare (810) & Fitsum (812) creeks; Lower Johnson Creek (805); & Lower (813), Middle (814) & Upper Secesh (815) rivers; Salmon River/China (901), Cottonwood (904), McKenzie (909), John Day (912) & Lake (913) creeks; Eagle (902), Deer (903), Skookumchuck (910), French (915) & Partridge (916) creeks	ST	2	2
Wind River (702), Salmon River/Rabbit (706) & Rattlesnake (710) creeks; & Big Mallard Creek (707); Burnt Log (806), Upper Johnson (807) & Buckhorn (811) creeks; Salmon River/Deep (905), Hammer (907) & Van (914) creeks	ST	2	1
Silver Creek (605)	ST	1	3
Lower (803) & Upper (804) East Fork South Fork Salmon River; Rock (906) & Rice (917) creeks	ST	1	2
Little Salmon #176021xxx			
Rapid River (005)	ST	3	3
Hazard Creek (003	ST	3	2
Boulder Creek (004)	ST	2	3
Lower Little Salmon River (001) & Little Salmon River/Hard Creek (002)	ST	2	2

Current PCE Condition	Potential PCE Condition
3 = good to excellent	3 = highly functioning, at historical potential
2 = fair to good	2 = high potential for improvement
1 = fair to poor	1 = some potential for improvement
0 = poor	0 = little or no potential for improvement

Watershed Name and HUC_5 Code(s)	Listed Species	Current Quality	Restoration Potential
Selway, Lochsa and Clearwater #1706030xxx			
Selway River/Pettibone (101) & Gardner (103) creeks; Bear (102), White Cap (104), Indian (105), Burnt Knob (107), Running (108) & Goat (109) creeks; & Upper Selway River (106); Gedney (202), Upper Three Links (204), Rhoda (205), North Fork Moose (207), Upper East Fork Moose (209) & Martin (210) creeks; Upper (211), Middle (212) & Lower Meadow (213) creeks; Selway River/Three Links Creek (203); & East Fork Moose Creek/Trout Creek (208); Fish (302), Storm (309), Warm Springs (311), Fish Lake (312), Boulder (313) & Old Man (314) creeks; Lochsa River/Stanley (303) & Squaw (304) creeks; Lower Crooked (305), Upper Crooked (306) & Brushy (307) forks; Lower (308), Upper (310) White Sands, Ten Mile (509) & John's (510) creeks	ST	3	3
Selway River/Goddard Creek (201); O'Hara Creek (214) Newsome (505) creeks; American (506), Red (507) & Crooked (508) rivers	ST	2	3
Lower Lochsa River (301); Middle Fork Clearwater River/Maggie Creek (401); South Fork Clearwater River/Meadow (502) & Leggett creeks; Mill (511), Big Bear (604), Upper Big Bear (605), Musselshell (617), Eldorado (619) & Mission (629) creeks, Potlatch River/Pine Creek (606); & Upper Potlatch River (607); Lower (615), Middle (616) & Upper (618) Lolo creeks	ST	2	2
South Fork Clearwater River/Peasley Creek (502)	ST	2	1
Upper Orofino Creek (613)	ST	2	0
Clear Creek (402)	ST	1	3
Three Mile (512), Cottonwood (513), Big Canyon (610), Little Canyon (611) & Jim Ford (614) creeks; Potlatch River/Middle Potlatch Creek (603); Clearwater River/Bedrock (608), Jack's (609) Lower Lawyer (623), Middle Lawyer (624), Cottonwood (627) & Upper Lapwai (628) creeks; & Upper (630) & Lower (631) Sweetwater creeks	ST	1	2
Lower Clearwater River (601) & Clearwater River/Lower Potlatch River (602), Fivemile Creek (620), Sixmile Creek (621) and Tom Taha (622) creeks	ST	1	1
Mid-Columbia #1707010xxx			
Wood Gulch (112); Rock Creek (113); Upper Walla Walla (201), Upper Touchet (203), & Upper Umatilla (301) rivers; Meacham (302) & Birch (306) creeks; Upper (601) & Middle (602) Klickitat River	ST	2	2
Glade (105) & Mill (202) creeks; Lower Klickitat River (604); Mosier Creek (505); White Salmon River (509); Middle Columbia/Grays Creek (512)	ST	2	1
Little White Salmon River (510)	ST	2	0

Current PCE Condition	Potential PCE Condition
3 = good to excellent	3 = highly functioning, at historical potential
2 = fair to good	2 = high potential for improvement
1 = fair to poor	1 = some potential for improvement
0 = poor	0 = little or no potential for improvement

Watershed Name and HUC_5 Code(s)	**Listed Species**	**Current Quality**	**Restoration Potential**
Middle Touchet River (204); McKay Creek (305); Little Klickitat River (603); Fifteenmile (502) & Fivemile (503) creeks	ST	1	2
Alder (110) & Pine (111) creeks; Lower Touchet River (207), Cottonwood (208), Pine (209) & Dry (210) creeks; Lower Walla Walla River (211); Umatilla River/Mission Creek (303) Wildhorse Creek (304); Umatilla River/Alkali Canyon (307); Lower Butter Creek (310); Upper Middle Columbia/Hood (501); Middle Columbia/Mill Creek (504)	ST	1	1
Stage Gulch (308) & Lower Umatilla River (313)	ST	0	1
John Day #170702xxx			
Middle (103) & Lower (105) South Fork John Day rivers; Murderers (104) & Canyon (107) creeks; Upper John Day (106) & Upper North Fork John Day (201) rivers; & Desolation Creek (204)	ST	2	2
North Fork John Day/Big Creek (203); Cottonwood Creek (209) & Lower NF John Day River (210)	ST	2	1
Strawberry (108), Beech (109), Laycock (110), Fields (111), Mountain (113) & Rock (114) creeks; Upper Middle John Day River (112); Granite (202) & Wall (208) creeks; Upper (205) & Lower (206) Camas creeks; North Fork John Day/Potamus Creek (207); Upper Middle Fork John Day River (301) & Camp (302), Big (303) & Long (304) creeks; Bridge (403) & Upper Rock (411) creeks; & Pine Hollow (407)	ST	1	2
John Day/Johnson Creek (115); Lower Middle Fork John Day River (305); Lower John Day River/Kahler Creek (401), Service (402) & Muddy (404) creeks; Lower John Day River/Clarno (405); Butte (406), Thirtymile (408) & Lower Rock (412) creeks; Lower John Day River/Ferry (409) & Scott (410) canyons; & Lower John Day River/McDonald Ferry (414)	ST	1	1
Deschutes #1707030xxx			
Lower Deschutes River (612)	ST	3	3
Middle Deschutes River (607)	ST	3	2
Upper Deschutes River (603)	ST	2	1
Mill Creek (605) & Warm Springs River (606)	ST	2	1
Bakeoven (608) & Buck Hollow (611) creeks; Upper (701) & Lower (705) Trout Creek	ST	1	2
Beaver (605) & Antelope (702) creeks	ST	1	1
White River (610) & Mud Springs Creek (704)	ST	1	0
Unoccupied habitat in Deschutes River/McKenzie Canyon (107) & Haystack (311); Squaw Creek (108); Lower Metolius River (110), Headwaters Deschutes River (601)	ST Conservation Value “Possibly High”		

Southern DPS Green Sturgeon

A team similar to the CHARTs, referred to as a Critical Habitat Review Team (CHRT), identified and analyzed the conservation value of particular areas occupied by southern green sturgeon, and unoccupied areas they felt are 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 freshwater rivers north of and including the Eel River, the areas upstream of the head of the tide were not considered part of the geographical area occupied by the southern DPS. However, the critical habitat designation recognizes not only the importance of natal habitats, but of habitats throughout their range. 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; the lower Columbia River estuary; 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) and freshwater (USDC 2009). Table 10 delineates physical and biological features for southern green sturgeon.

Table 10. Physical or biological features of critical habitat designated for southern green sturgeon and corresponding species life history events.

Physical or Biological Features Site Type	Physical or Biological Features Site Attribute	Species Life History Event
Freshwater riverine system	Food resources Migratory corridor Sediment quality Substrate type or size Water depth Water flow Water quality	Adult spawning Embryo incubation, growth and development Larval emergence, growth and development Juvenile metamorphosis, growth and development
Estuarine areas	Food resources Migratory corridor Sediment quality Water flow Water depth Water quality	Juvenile growth, development, seaward migration Subadult growth, development, seasonal holding, and movement between estuarine and marine areas Adult growth, development, seasonal holding, movements between estuarine and marine areas, upstream spawning movement, and seaward post-spawning movement
Coastal marine areas	Food resources Migratory corridor Water quality	Subadult growth and development, movement between estuarine and marine areas, and migration between marine areas Adult sexual maturation, growth and development, movements between estuarine and marine areas, migration between marine areas, and spawning migration

The CHRT identified several activities that threaten the PCEs in coastal bays and estuaries and necessitate the need for special management considerations or protection. The application of pesticides is likely to adversely affect prey resources and water quality within the bays and estuaries, as well as the growth and reproductive health of Southern DPS green sturgeon through bioaccumulation. Other activities of concern include those that disturb bottom substrates, adversely affect prey resources, or degrade water quality through re-suspension of contaminated sediments. Of particular concern are activities that affect prey resources. Prey resources are affected by: commercial shipping and activities generating point source pollution and non-point source pollution 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 (but result in beneficial or adverse effects on prey resources for green sturgeon). In addition, petroleum spills from commercial shipping and proposed hydrokinetic energy projects are likely to affect water quality or hinder the migration of green sturgeon along the coast (USDC 2009).

2.3. Action Area

"Action area" means all areas to be affected directly or indirectly by the federal action and not merely the immediate area involved in the action (50 CFR 402.02).

The action area is defined by the distance from the impact pile driver where sound pressure levels from driving 24-inch diameter steel pipe pile exceeds 150 dB_{RMS} (re 1 μPa). The radial distance is 4640 meters in water or to the point where the sound pressure wave reaches a solid barrier to transmittal. The shape of the action area is shown in green in Figure 4. The action area spans the mouth of the Columbia River. This impact has the greatest areal extent of any effect of the proposed action.

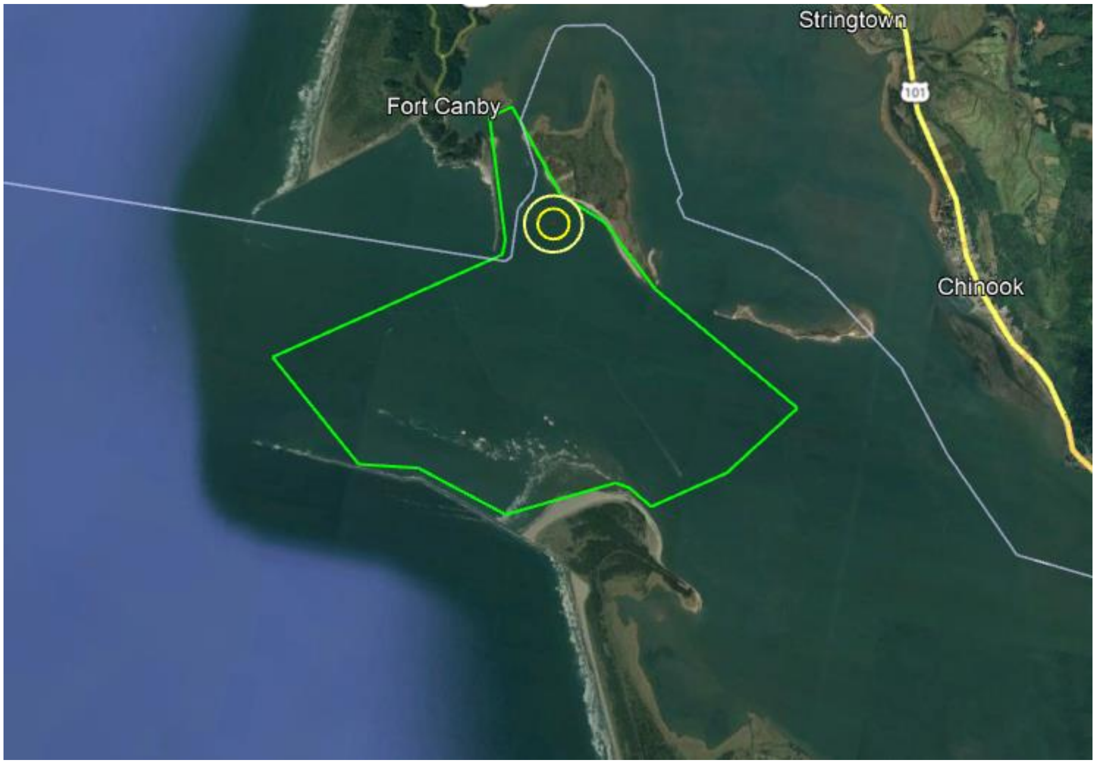

Figure 4. West Sand Island pile dike repair action area.

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 impacts to listed species or designated critical habitat from federal agency activities or existing federal agency facilities that are not within the agency's discretion to modify are part of the environmental baseline (50 CFR 402.02).

General Baseline Impacts

Virtually the entire LCR channel and riparian zone has been degraded by the effects of forest management, agriculture, mining, transportation, and urbanization, as well as the use of LCR water for hydropower, consumption, irrigation, heat transfer, transportation and recreation. These economic activities contribute to; degraded water quality, changes in channel morphology, reduced instream roughness and cover, degraded riparian functions, and lost estuarine rearing habitats such as wetlands, and floodplains. Climate change is likely to play an increasingly important role in determining the fate of ESA-listed species and the conservation value of their designated critical habitats in the LCR as described in Section 2.2.

Dams, reservoirs, and levees greatly alter LCR habitat complexity, water quality and water quantity. Dams and levees have disconnected floodplains and off-channel habitat features from the main channel. Dams and reservoirs reduce the supply of large woody debris in the LCR, reduce spring turbidity levels, reduce flow volumes and rates, increase water temperature, and alter food webs (Ferguson, Matthews et al. 2005, Williams, Smith et al. 2005). Dams without adequate fish passage systems extirpated some anadromous fish populations. Today fish passage to habitat above dams is being restored through improvements to fish passage facilities or dam removal such as Marmot Dam on the Sandy River and Powerdale Dam on the Hood River.

Birds, other fish and marine mammals, prey on juvenile or adult salmon in the Columbia River. Caspian terns, double-crested cormorants, glaucous-winged/western gull hybrids, California gulls, and ring-billed gulls are the main avian predators. Avian predators congregate near hydroelectric dams and nest in the LCR on islands made from dredged sediment and other man-made structures. They benefit from dams and reservoirs because low flow velocity increases smolt migration time and suspended sediment deposition in reservoirs reduces turbidity below the dam. Smolt bypass systems in dams concentrate fish at the bypass entry points making them easier for avian predators to catch. The Columbia River Basin also has native and introduced fish species that prey on salmon and steelhead. The primary resident fish predators of salmonids are northern pikeminnow (native), smallmouth bass (introduced), and walleye (introduced). Other predatory resident fish are channel catfish (introduced), Pacific lamprey (native), yellow perch (introduced), largemouth bass (introduced), and bull trout (native). Seals and sea lions have learned to hunt returning adult salmon and steelhead in the LCR and take advantage of the constricted passages past Bonneville Dam and Willamette Falls.

The environmental baseline includes the anticipated impacts of all Federal actions in the action area that have already undergone formal consultation. The USACE, Bonneville Power Administration (BPA), and Bureau of Reclamation have consulted on large water management actions, such as operation of the Federal Columbia River Power System, the Umatilla Basin Project, and the Deschutes Project. The U.S. Bureau of Indian Affairs (BIA), U.S. Bureau of Land Management, and the U.S. Forest Service (USFS) have consulted on Federal land management throughout Oregon and Washington, including restoration actions, forest management, livestock grazing, and special use permits. The BPA, NOAA Restoration Center, and USFWS have also consulted on large restoration programs that consist of actions designed to address species limiting factors or make contributions that would aid in species recovery.

Baseline impacts specific to the proposed action

USACE is responsible for 233 pile dikes constructed from 1885 to 1969 between the Columbia River mouth and the Bonneville Dam. Pile dikes are wooden piles driven into an enrockment base that establish the alignment and velocity distribution of the discharge through reaches of the river. By retarding the flow behind, over and through the dike, the flow around the dike must accelerate to keep up with discharge. Pile dikes were constructed to align the channel but as empirical data on the relationship between dike dimensions and location and dredging requirements accumulate, their length and height can be adjusted such that the mean velocity for any discharge is optimized to balance the movement of sediment in straight and meandering sections of the river to minimize maintenance dredging (Lamb and Ethridge 1990). Because maintenance dredging of the FNC and the disposal of FNC dredge material have significant adverse effects to ESA listed species and their critical habitat, the presence of pile dikes offsets some of these adverse effects. However, the existing pile dikes have their own adverse effects to ESA listed species and critical habitat. Specifically, they obstruct downstream passage of some migrating salmon and steelhead and they provide avian predators with hunting perches right at this point of passage obstruction.

Over the past 120 years the LCR channel has been narrowed, deepened and smoothed. Floodplains[3] have been converted to farmland behind revetments and tide gates. Pile dikes and three jetties at the mouth reduce the physical channel width while upriver dam reservoir management reduces the wetted channel width[4]. Dredging has approximately doubled the controlling depth at the mouth of the Columbia River[5]. Increased depth reduces average friction and decreases the backwater surface slope. Elimination of roughness elements such as floodplain vegetation and large woody debris reduce frictional drag. For discharges below 300,000 cubic feet per second friction drag from bedload transport is quite low as sand waves typically move only a few feet per day. Helaire, Talke et al. (2019) estimated that today, Chezy roughness coefficients range from 55-96 $\frac{m^2}{s}$ compared to 25-50 $\frac{m^2}{s}$ in the late 1800's. So even though estuary discharges are regulated and generally reduced, discharge velocity and bed stress have increased while water levels have decreased[6]. Pile dikes restore some roughness and friction back to the channel. Pevey, Savant et al. (2020) modeled the rock base of current pile dikes with a mannings 'n' of 0.05, which would be a Chezy C of 43-49 at river depths from 10-20 feet.

The BBW Pile Dike system consists of four pile dikes along the west side of Sand Island, identified by their position (river mile) along the BBW FNC (BB0.28, BB0.56, BB0.70, and BB0.86). They prevent erosion into the BBW FNC, protect Sand Island from winter storm surge and direct the ebb tide flow over the MCR bar. The pile dike system has deteriorated. Most of the pile spreaders are no longer intact, many piles are damaged or missing and BB0.56 and BB0.28 are no longer connected to the West Sand Island shore. Historically, annual dredging volumes in the BBW FNC averaged 55,000 cubic yards (CY) per year (1985 - 2005). However, since 2005, as the pile dikes have deteriorated, annual dredging volumes have increased to 76,000 CY/year and shoals in the FNC have become more unpredictable requiring emergency dredging. The BBW FNC now must be dredged annually during the August 1 to December 15 work window taking an average of 15 to 45 days. The velocity of the fraction of the discharge that enters the channel between West Sand Island and the Washington shoreline is a function of the tidal cycle. At a discharge of 343,000 cfs and slack tide, the velocity entering the West Sand Island channel is around 3 ft/s. The West Sand Island channel expands so without the pile dike the velocity would decrease to around 1.3 ft/s. With the pile the mean velocity is 2.4 ft/s. The altered bathymetry, reduced channel friction and reduced sand supply also increases the inundation of

3 Approximately 68-70 percent of the vegetated tidal wetlands and 55 percent of forested uplands have been lost in the LCR since the late 1800s Helaire, L. T., S. A. Talke, D. A. Jay and D. Mahedy (2019). "Historical Changes in Lower Columbia River and Estuary Floods: A Numerical Study." Journal of Geophysical Research-Oceans **124**(11): 7926-7946..

4 Flow regulation has reduced the 2-year flood peak discharge from 580,000 to 360,000 cfs ibid..

5 Ibid.. The mouth of the river and the six miles of the inboard side of the mouth of the Columbia River is maintained at 14.6 m depth while the six miles on the outboard side are maintained at 16.8 m depth.

6 Mean water levels at Vancouver (river kilometer 170) dropped between 0.3 and 1.5 m since 1902, for river flow levels from $2.5 - 15\frac{m^3}{s}$.

tide waves. Tides in the project area are mixed semi-diurnal, with two high tides and two low tides each day. Between the mean higher high water (MHHW) and mean lower low water (MLLW), the water surface elevation ranges a total of 7.8 feet. Tides are the primary driver of water velocities in Baker Bay. Tidal currents may exceed 3.3 ft/s during peak ebb or flood. Between BB0.28 and the West Sand Island shoreline, depth-averaged velocities reached 4 ft/s during spring tides. The critical velocity for sediment movement in this area is on the order of 1 ft/s, indicating ample capacity for erosion in the action area.

Pile dikes are common features of tidal rivers and estuaries that have been modified for navigation all over the United States and the rest of the world (Fletcher 1983, Lamb and Ethridge 1990, Deng, Cao et al. 2019, Huang, Lu et al. 2019). Pile dikes are more expensive than conventional rock dikes and have adverse effects to fish passage and predation. Hammack, Johnston et al. (2019) ran a 3D, non-hydrostatic Navier Stokes numerical flow solution model with a Reynolds Averaged Navier Stokes (RANS) turbulence model, of a pile dike and a rock dike at a flow site at Cottonwood Island to evaluate which design better deflects fluvial and tidal energy from the bank line to the navigation channel (Figure 5). The pile dikes produce 0.5 to 1.5 feet per second lower velocity at the surface because the piles obstruct flow at the water surface. Rock dikes are completely submerged allowing water at the surface to flow more quickly. For both dike types, eddies are present immediately downstream from each dike. These eddies extend along the length of the dike and approximately ¼ of the distance between two dikes.

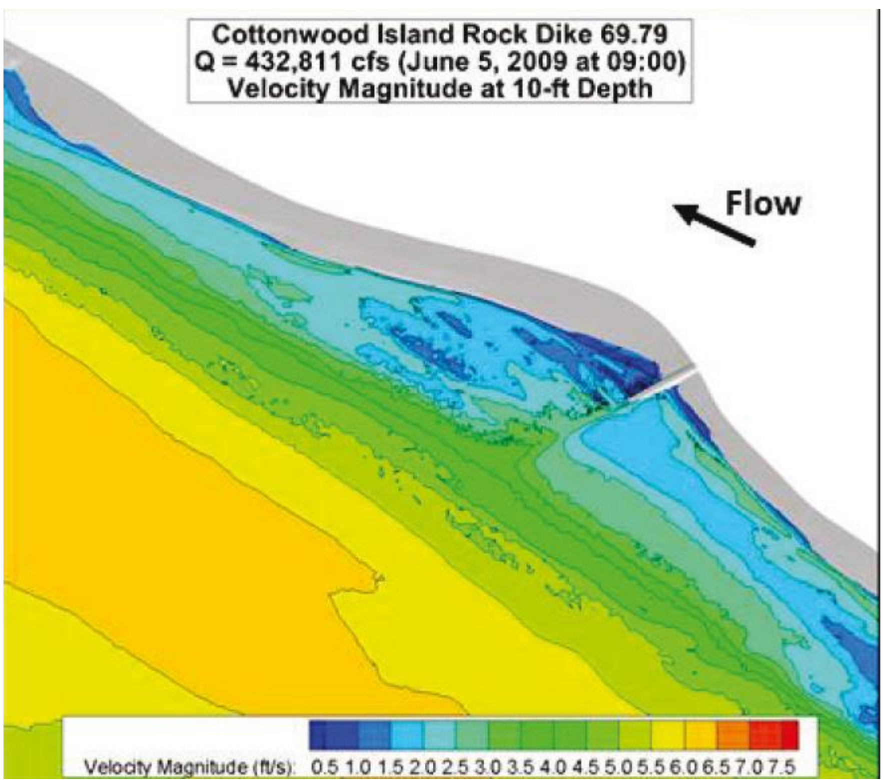

Figure 5. Cottonwood Island rock dike velocity distribution across channel.

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 but that are not part of the 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 402.02).

The proposed actions would have multiple types of effects, ranging from temporary to enduring. The temporary effects associated with construction include fish handling inside of the sheet pile containment, entrainment during dredging, water quality impairment (turbidity), noise in aquatic habitat, and reduction in benthic communities and forage species reductions. The enduring effects associated with structures in the aquatic habitat include alteration of predator/prey dynamics (predation), hydraulic changes, reduction in benthic communities and forage species reductions, and fish passage/migration impediment.

2.5.1. Effects on Listed Species

Temporary Effects to Listed Species

Fish handling

As the sheet pile enclosure nears completion, the USACE proposes to relocate fish from the structure. Capture and handling of fish induces stress and can increase plasma levels of cortisol and glucose, decrease growth, decrease reproductive capabilities, increase vulnerability to predation, and increase the likelihood of mortality. Electrofishing significantly increases the chance of harm, injury, or mortality. The likelihood of adult salmonids becoming trapped in the enclosure is extremely unlikely due to their ability and tendency to avoid the disturbance area. Juvenile salmonids are more likely to become trapped in the enclosure because they tend to occupy shallow water habitats, despite their low density associated with the in-water work windows. It is highly likely that if fish are handled, injury and/or mortality would occur among a portion of the individuals captured. Although the likelihood of encountering listed salmonids during exclusion and relocation efforts is low, we cannot, based on the best available science and data rule out the possibility that listed fish would be captured and handled; handling even a small number of handled ESA-listed salmonids would constitute an adverse effect, even though the handling is intended to reduce exposure to other adverse exposures. Green sturgeon that are likely to be present in the lower Columbia River estuary during construction are very unlikely to be present in the shallow water associated with the sheet pile installation. Effects to green sturgeon from fish handling is very unlikely.

Pile Driving Noise

The proposed action includes pile driving twelve 12-24-inch marker piles and 16 24-inch dolphin piles. Impact pile driving is proposed for the marker piles because they must be driven through the rock dike. The 24-inch steel pipe piles create noise greater than 150 dB_{RMS} (re: 1μPa) within 4640 meters of the pile (NMFS 2021) and the action area is approximately 21,000,000 square meters (determined with Google Earth). Impact pile driving creates sound pressure greater than

206 dB_{peak}, 187 dB_{SEL} and 182 dB_{SEL} (for fish < 2 grams) within 6 meters, 233 meters and 431 meters (for fish < 2 grams) of the pile[7]. Vibratory pile driving of 12 - 24-inch steel pipe piles and 24-inch AZ steel sheet piles creates noise greater than 150 dB_{RMS} (re: 1μPa) within 2,000 feet of the pile (Buehler et al. 2015).

Impact pile driving can cause high levels of underwater sound in the aquatic habitat. The use of a confined or unconfined bubble curtain has resulted in significant noise reduction (mean attenuation up to 36 dB), but is dependent on the project location and can be inconsistent and unpredictable (WSDOT 2020). In this opinion, NMFS assumes that the USACE is not proposing to use a bubble curtain as the conditions under which its use would be effectively implemented are uncertain (USACE 2023).

No instances of fishes or marine mammals killed or injured have been associated with vibratory pile driving. However, high levels of noise, including noise from impact and vibratory pile driving, can result in temporary shifts in hearing sensitivity, masking, and behavioral effects in fish. Because of the paucity of data on the response of salmon to pile driving sounds, NMFS is currently using a conservative level of 150 dB RMS as a trigger for analysis of potential adverse behavioral effects from all types of sounds, including those from impact and vibratory hammers. NMFS' overall synthesis of the best available science leads us to our findings. Studies in which these effects have been studied for salmonids include, Grette 1985 (Chinook and sockeye salmon), Feist et al. 1996 (chum salmon), Ruggerone et al. 2008 (coho salmon), Popper 2003 (on behavioral responses of fishes).

In this Opinion, the potential for adverse behavioral effects will be most important to juvenile Chinook salmon that are outmigrating and overlap with pile driving, because they face a greater risk of predation than subadult or adult fish in marine waters. The Fisheries Hydroacoustic Working Group (FHWG, 2008) determined that SPLs in excess of 150 dB_{RMS} are likely to cause temporary behavioral changes, including a startle response or other behaviors indicative of stress. Popper et al. (2003) reports that behavioral response of fishes to sounds may include "freezing", increasing the vulnerability of individual fish to predation.

The August 1 to November 30 work window overlaps the upstream migration of adult fall Chinook, coho and winter steelhead, the end of the downstream migration of smolts from all 13 ESU/DSPs through the action area and some rearing of LCR juvenile salmon and steelhead in the estuary, although most rearing is upstream from the action area in less salty water (Roegner, McNatt et al. 2012). Marker piles will be installed with vibratory and impact pile driving during two days of this window. Fewer than 150,000 ESA listed adult salmon and steelhead migrated through the lower Columbia River each year between 2015 and 2020 (Ford 2022) so hundreds of adults may swim through the 21,000,000 square meter affected area each day. The density of smolts in the estuary drops dramatically in August - September, from 1,000s of fish per 1,000 square meters to 10s of fish per 1,000 square meters (Roegner et al., 2016) so up to 1,000 smolts could be in the 21,000,000 square meter action area each day.

[7] No sound attenuation due to strong tidal currents.

In Table 11, we scale these fish density estimates to the fraction of the size of the peak and SEL circles to the vibratory pile driving RMS area. It is extremely unlikely that either an adult or juvenile will be in the peak circle to be injured or killed by a single impact strike. It is also extremely unlikely that an adult or juvenile salmon or steelhead will be in the RMS circle for vibratory driving of steel pipes or sheet pile. Perhaps 8 adults and 8 juveniles greater than 2 grams or 28 juveniles less than 2 grams could be exposed to the SEL sound pressure. However, we don't have a way to translate these numbers into an exact estimate of the number of fish that would remain in the RMS circle to accumulate vibrations from the impact pile driver all day so as to be injured or killed. Logically, migrating adults are extremely unlikely to stop the entire day but some foraging juveniles could spend the day in one place. Therefore, we expect that some juvenile salmon will be exposed to harmful noise, which may include mortality and behavioral changes associated with pile driving. These effects will be limited by the in-water work window when the density of juvenile salmon in the action area will expose very few fish to noise effects. Similarly, whereas adult salmonids are more likely to be in the action area, they are far more likely to evade and avoid the work area. Adult and juvenile salmonids are likely to modify their behavior to minimize exposure to noise, but pile driving noise is spatially extensive and is likely to affect adult and juvenile salmonids.

During the late summer and early fall, subadult and adult green sturgeon aggregate in estuaries along the Pacific coast, including Baker Bay, from July through October. Moser and Lindley (2007), hypothesized that green surgeon optimize their growth potential in the summer by foraging in the warm, saline waters during high tides. Subadult and adult green sturgeon in the estuary during the late summer are less vulnerable to pile driving noise than juvenile salmon because they are larger and thus better able to escape the noise zone quickly and because they have a primitive physostomous swim bladder that is less prone to rupture (Halvorsen et al., 2012). While there may be some displacement of green sturgeon from the immediate construction area during vibratory pile driving, we expect that physical injury will not occur and behavioral changes will be short-lived and limited to a small area immediately adjacent to the construction area. However, impact driving during construction extends up to 4,640 meters into the estuary from the impact driver. The effect of the impact driver on green sturgeon will force them to abruptly alter their behavior and abandon feeding while finding refuge from the noise. The work windows associated with construction are likely to minimize the co-occurrence of green sturgeon and impact driving, however, some adult and sub-adult sturgeon are likely to be present and harmed by the noise.

Table 11. Salmon and steelhead densities estimates associated with the size of the peak and SEL circles to the vibratory pile driving RMS area.

	Number	Sound Pressure Effect Threshold	Strikes (minutes for vibratory)	Radius (m)	Area (m^2)	Fraction of Action Area	Adults	Juveniles	Effect
24-inch steel pipe piles	9	Vibratory (150 dB re: 1 μPa)	585	16	804	0.0000	0	0	Behavior
		Impact, peak Amplitude (206 dB re: 1 μPa)	1	6	113	0.0000	0	0	Injury, death
		Impact, sound exposure level for fish >2 g (187 dB re: 1 μPa^2/s)	1125	233	170554	0.0081	4	8	Injury, death
		Impact, sound exposure level for fish <2 g (182 dB re: 1 μPa^2/s)	1125	431	583585	0.0278	14	28	Injury, death
		Impact, root mean square (150 dB re: 1 μPa)	1125	4642	2.1E+07	1.0000	500	1000	Behavior
24-inch AZ sheet pile	225	Root mean square (150 dB re: 1 μPa)	10	46	6648	0.000317	0	0	Behavior
18-inch piles	16	Root mean square (150 dB re: 1 μPa)	10	16	804	3.83E-05	0	0	Behavior

Entrainment

The Corps proposes to excavate (dredge) the substrate, largely sand, from the temporary barge or landing structure, potentially exposing fish to entrainment. Entrainment is the process where objects are enclosed and transported within some form of vessel or where solid particles are drawn-in and transported by the flow of a fluid. In this context, entrainment refers to the uptake of aquatic organisms by dredge equipment. Mechanical (clamshell) dredges entrain organisms that are captured within the clamshell bucket. The likelihood of entrainment increases with a fish's proximity to the dredge, and the frequency of interactions.

Mechanical (clamshell) dredges commonly entrain slow-moving and sessile benthic epifauna along with burrowing infauna that are removed with the sediments. They also entrain algae and aquatic vegetation. There is little evidence of mechanical dredge entrainment of mobile organisms such as fish. In order to be entrained in a clamshell bucket, an organism, such as a fish, must be directly under the bucket when it drops. The small size of the bucket, compared against the distribution of the organisms across the available habitat make this situation is very unlikely, and that likelihood would decrease after the first few bucket cycles because mobile organisms are most likely to move away from the disturbance. Further, mechanical dredges move very slowly during dredging operations, with the barge typically staying in one location for many minutes to several hours, while the bucket is repeatedly lowered and raised within an area limited to the range of the crane arm. Most fish in the vicinity of the dredge at the start of the operation would likely swim away to avoid the noise and activity. Carlson et al. (2001) documented the behavioral responses of salmonids to dredging activities in the Columbia River using hydroacoustics. During dredging operations, out-migrating salmon smolt (*Oncorhynchus* spp., likely fall Chinook salmon and coho salmon (*O. kisutch*)) behavioral responses ranged from (1) salmon orienting to the channel margin move inshore when encountering the dredge, (2) most out-migrating salmon passing inshore moved offshore upon encountering the discharge plume, and (3) out-migrating salmon were observed to assume their prior distribution trends within a short time after encountering both the dredging activity and dredge plume" (Kjelland et al. 2015).

Entrainment can also occur during material placement, when the sand/rock fall through the water column, and creates a plume that extends from the bottom of the vessel to the seafloor. Fish that are above the point of discharge or are otherwise not directly below a discharge plume are likely to detect the plume and attempt to evade the descending material as a perceived threat. Based on the available research, fish are likely to initially dive and then initiate horizontal evasion. Fish that are below a discharge plume are likely to initially dive and then initiate horizontal evasion, or to simply move laterally if already on or near the bottom. The determining factor in avoiding entrainment will be whether the fish can swim fast enough to move out of the discharge field once the fish detects the threat. The risk of entrainment would increase with proximity to the center of the plume and/or to the seafloor. Individuals that become entrained, or are unable to escape before contact with the substrate are likely to be buried under the sediments. The likelihood of injury or mortality would again increase with proximity to the center of the discharge field where depth and weight of the sediments would be greatest.

As stated above, the probability of fish entrainment is largely dependent upon the likelihood of fish occurring within the dredge prism, dredge depth, fish densities, the entrainment zone (water column of the clamshell impact), location of dredging within the river, type of equipment operations, time of year, and species/life stage. Demersal fish, such as sand lance and sculpins, are most likely to be entrained as they reside on or in the bottom substrates with life-history strategies of burrowing or hiding in the bottom substrate (Nightingale and Simenstad 2001). Consequently, the risk of entrainment of ESA-listed salmonid species or green sturgeon by the dredge is extremely low and no incidental take of either species is expected.

Turbidity

Vibratory pile driving will result in elevated concentrations of suspended sediment. NMFS reviewed data generated from a pile removal project near the mouth of Jimmycomelately Creek in Sequim Bay (Weston Solutions, 2006) to predict the potential effects of suspended sediment from vibratory pile driving. Total suspended solid (TSS) concentrations from the tug boat propeller wash as it maneuvered the pile driver barge to and from pile locations exceeded 50 to 100 milligrams per liter (mg/L). TSS generally returned to background levels of 10 mg/L or less within 5 minutes. TSS concentrations associated with activation of the vibratory hammer to loosen the pile from the substrate ranged from 13 to 42 mg/L and averaged 25 mg/L. TSS was sometimes visible in the water column as a 10 to 16-foot diameter plume that extended at least 15 to 20 feet from the actual pulling event. Any individual fish near the pile-substrate interface will be exposed to up to 100 milligrams per liter of suspended sediment during and for a short time following vibratory pile driving. Wilber and Clarke (2001) report that adults exposed to 10-100 milligrams per liter of suspended sediment for less than 2 hours will result in behavioral effects such as reduced visual acuity and altered swimming either toward or away from suspended sediment and that juvenile fish exposed to 10 to 100 milligrams per liter for 8 hours would experience sublethal physiological effects such as reduced feeding and behavioral effects such as alarm followed by relocation. They note that these effects are somewhat offset by the ability of smolts to hide from predators in the turbidity associated with suspended sediment.

Clamshell dredging creates a suspended sediment plume as the bucket digs into the substrate and as sediment falls from the bucket as it rises through the water column. The suspended sediment source concentration empirical equation $\frac{C}{\rho x 10^{-6}} = .0023 \left(\frac{b}{v_s T}\right)^3$, where b is the clamshell bucket size and v_s is the Stokes law settling velocity of the sediment particles, shows that the plume can be managed by increasing the dredge bucket cycle time, T (Collins 1995). A hydraulic dredge has a cutter head that digs into and loosens the sediment causing some to enter the water column. Any suspended sediment from hydraulic dredging will be in a small, highly concentrated plume around the cutter head (Wilber and Clarke 2006).

The July to November work window overlaps the presence of juvenile salmon and steelhead in the action area and the migration of adult salmon and steelhead through the action area. BMPs and the low density of fish in the estuary during the work window are likely to minimize the number of individual fish exposed to suspended sediment from vibratory pile driving. Nevertheless, turbidity from the dredging installation and removal of piles will co-occur when some juvenile Chinook, coho, sockeye, and chum salmon are likely to be present, and harm is likely to occur as a consequence to these species as a result.

The sediment plume from the proposed dredging and pile driving is not expected to rise to levels that would adversely affect green sturgeon that might be present in the action area. If present, these fish will not be restricted from avoiding the plume and will be of sufficient size to avoid potential adverse effects from elevated suspended sediments within the plume. Harm to green sturgeon due to turbidity effects are not expected.

Benthic communities and forage reduction

When juvenile salmonids are entering the estuary or marine environment, they must have abundant prey to allow their growth, development, maturation, and overall fitness. As dredging dislodges bottom sediments, benthic communities are disrupted. Benthic communities will be impacted over approximately 5,000 sqft as a result of the placement of the coffer dam, which may impede recolonization of benthic communities for more than two years. Under the Barge option, up to 2,800 sqft. of material would be dredged, which also would require at least two years before recolonization of the benthic community would begin. It can take up to three years to fully re-establish their former abundance and diversity once the impediments (barge or coffer dam) were removed.

Work will occur across two work windows so we can expect five years in which benthic prey is less available to juveniles, incrementally diminishing the growth and fitness of six separate cohorts of ESA-listed juvenile salmonid species that pass through the action area. Given the relatively small area from within available prey sources in the river system, and the high level of mobility that juvenile migrants have when they reach the marine environment, that many individual fish will experience reduce food or increased competition to a degree that impairs their growth, fitness, or survival. Even if several fish from each cohort of each population had diminished foraging success, we anticipate that this would be a transitory condition as they migrate to more suitable forage locations. The level of reduced growth, fitness, or survival would be impossible to detect numerically, and the reduced abundance in juvenile cohorts would probably be insufficient to be discerned as an influence on productivity of the populations.

In their return migration, adult Chinook salmon largely cease eating as they enter fresh water, so the reduced prey availability in the action area is unlikely to adversely affect them. Adult steelhead are iteroparous, and will continue to consume prey as returning adults, but as larger fish, they are likely to seek out much larger prey than the benthic assemblies would provide, meaning the reduced benthic prey availability is also unlikely to exhibit a significant effect to adult steelhead. Similarly, green sturgeon would likely move a short distance away from the project area and resume the consumption of benthic invertebrates without incurring a discernable effect.

Enduring Effects to Listed Species

Fish Passage

Fish passage is currently obstructed by BB 0.28 because the piles extend above the surface of the water at all tide elevations. The Corps proposes to replace the wooden piles with a rocked dike. The proposed replacement rock dike is 3,439 ft long. Most of the dike will be submerged during high tides, but exposed at the surface during MLLW tides. The new replaced dike will feature fish passage notches to facilitate juvenile salmon passage at three locations along the dike. The notches are designed so that fish can pass through at nearly all tidal elevations in at least two of the notches. They are positioned close to shore where juvenile Chinook, chum, sockeye, and coho salmon are expected to migrate. The notches are novel fish passage design element and their effectiveness is untested.

The rock dike will impede juvenile salmon migration along their nearshore migration routes. NMFS anticipates that the notches would improve fish passage relative to an unnotched rock dike, but that fish passage would be blocked along most of the length of the dike at low tides. Obstructed fish passage can force juvenile salmon into deeper water where they are subjected to increased predation pressures. The rock dike will impede fish passage and will negatively impact juvenile salmon for decades. Adult salmonids, juvenile steelhead and sub-adult and adult green sturgeon are unlikely to use the nearshore, or fish passage notches, in the project area and the the rock dike is not expected to impede passage for these species and life histories.

Predation

The USACE proposes to remove 486 wooden piles from the pile dike, which currently provides hunting perches for avian predators of juvenile salmon and steelhead. When combined with obstructed fish passage they give predators an unnatural advantage over their ESA-listed prey. The proposed action eliminates most of the piles, which would greatly reduce avian predation on juvenile salmonids in the action area. However, the replacement rock dike may increase piscivorous predation. As described above, obstructed fish passage can force juvenile salmon into deeper water where they are subjected to increased predation pressures. The rock dike will increase piscivorous predation and negatively affect juvenile Chinook, chum, coho, and sockeye salmon. This increase is not expected to result in predation levels sufficient to affect population abundance or productivity.

Benthic Habitat

By placing large amounts of additional rock, the proposed action extends the life of the rock portion of the dike. This area covers up to 206,000 square feet of soft (sandy), estuarine, benthic substrate. Sandy substrate provides habitat to the benthic food guild that naturally produces macroinvertebrate prey for salmon and steelhead growth and energy. However, hard substrate such as large rocks creates habitat for different food guilds that may also produce macroinvertebrates and provide other environmental services. Wetzel, Scholle et al. (2014) found that in the Weiser estuary in Germany, the benthic hard substrate community inhabiting rock groins was significantly different from the nearby soft substrate community but had much higher total abundance and biomass per square meter than the soft substrate and had much higher abundance of filter feeding organisms that link benthic and pelagic food webs and improve water quality. We don't know if the hard substrate provides more or less food biomass for salmonids than the soft substrate it covers but Hall, Herbert et al. (2018) and Pioch, Relini et al. (2018) describe how in the future, hard structures constructed in estuaries to counter seal level rise will be manipulated to replace the soft substrate ecological services they displace. In this case, the proposed action rehabilitates a hard structure and that covers an extremely small fraction of the natural soft substrate in the project area. In summary, the proposed action does not reduce the amount of benthic macroinvertebrate prey in the project area but rather changes the composition of that prey from food guild to another. The overall effect on migrating salmonids is likely neutral to slightly negative. Due to the small amount of habitat affected, relative to the surrounding area, this effect is not expected to be meaningful.

Hydraulics

The removal of the timber piles from the current pile dike will likely increase the mean velocity in the recirculation zone behind pile dike from 0.5 to 1.5 feet per second (Pevey, Savant et al.

2020) and water flowing over the top of the rock structure will increase the creation of vertical eddies in addition to the horizontal eddies created by the lateral structure itself. We do not know if these changes in turbulence will be a more attractive to salmon and steelhead than the turbulence created by the current timber pile configuration because the size of the eddy diameters (Chen, Lu et al. 2022) has not been modeled and the turbulent eddy diameter distribution determines whether fish are attracted to, tolerate or are repelled by the turbulence created by a structure in the river (Liao, Beal et al. 2003, Liao 2007, Wilkes, Maddock et al. 2013, Cotel and Webb 2015). Engineers and biologists are currently investigating how flow control structures can be designed to produce turbulent flow patterns that increase their habitat value to all species (Koken and Constantinescu 2009, Wilkes, Maddock et al. 2013, Koken and Gogus 2015). For BB 0.28, the removal of the timber piles likely creates flow patterns that are more similar to natural shallow water flow than the existing configuration (Pevey, Savant et al. 2020). Thus, we expect that the changes from a pile-dominated dike to a rock-dominated dike will have a negligible effect on salmon and steelhead.

2.5.2. Effects to Salmon and Steelhead Critical Habitat

Water Quality

During construction, water quality will be diminished by noise from pile driving and turbidity from pile driving and dredging. A new, temporary source of noise such as pile driving only affects salmon and steelhead critical habitat insofar as it directly affects those species because once the construction is complete, the critical habitat returns to normal. The effects to the critical habitat PBF are short-term and not expected to be consequential in the long term.

Obstructed Passage and Predation

As described above, the proposed action reduces the avian predation effect by eliminating 486 timber piles and adding notches at the shallow water section of the dike so that under most tide elevations, fish can swim over or through the dike. Nevertheless, the proposed addition of rock would cause the dike to impair fish passage several more decades. The addition of 12 steel marker piles will result in a small amount of piscivorous predation on juvenile salmonids as those piles would obstruct migration.

Forage

The proposed action is unlikely to alter the overall quantity of salmon and steelhead forage in the project area. Although any forage produced by the benthic community will be diminished with the addition of new rock and marker piles, the total submerged, hard surface substrate area of the structure will increase as the height and width of the pile and rock structure is increased. Additionally, 486 timber piles will be eliminated, which will likely increase benthic forage.

2.5.3. Direct Effects to Humpback Whales

Pile Driving Noise

The proposed action includes impact and vibratory pile driving to install 12 24-inch diameter steel pipe channel marker piles and vibratory pile driving to install a temporary sheet pile coffer dam and four mooring dolphins, each composed of four 24-inch steel piles, at the material offloading facility. Impact and vibratory pile driving noise adversely affects marine mammals and the USACE applied to NMFS PRD for a Marine Mammals Protection Act (MMPA) Incidental Harassment Authorization (IHA). MMPA Level A harassment is "…any act of pursuit, torment or annoyance, which has the potential to injure a marine mammal or marine mammal stock in the wild". Humpback whales have entered the action area during the August 1 to November 28 in-water work window and two humpback whales were observed in the action area during the Sand Island test pile project. Humpback whales are low frequency hearing cetaceans. The impact pile driving permanent threshold shift (PTS) sound thresholds for low frequency cetaceans are 219 dB_{peak} (re: 1 μPa) and 183 dB_{SEL} (re: 1 $u Pa^2/sec$). For vibratory pile driving the PTS sound threshold is 199 dB_{SEL} (re: 1 $u Pa^2/sec$). NMFS PRD determined that sound pressure levels from impact pile driving of 12 24-inch diameter steel pipe piles exceed the Level A harassment threshold (183 dB_{SEL}) within 510 meters of the pile driver and that vibratory pile driving of 24 inch sheet pile exceeds the Level A harassment threshold (199 dB_{SEL}) within less than 50 meters of the pile driver. To mitigate this risk the USACE proposes to monitor for the presence of humpback whales and shutdown pile driving if humpback whales are observed approaching these distance threshold (89 FR 60385). PRD concluded that, for the purposes of MMPA, the monitoring and shutdown procedure prevents MMPA Level A harassment. The proposed action is likely to result in MMPA Level B harassment, during which no injury occurs, but the humpback whale behavior patterns are disturbed. This disturbance is likely to last a few hours at most, with no long-term effects to any humpback whales from the Mexico or Central America DPSs.

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]. 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 earlier in the discussion of environmental baseline (Section 2.4).

It is reasonably certain that over the additional service life of the project, climate effects such as modified water temperatures, altered river hydrograph, and shifting salinity will all exert more influence on the habitat quality and related carrying capacity. NMFS expects State and private activities near and upriver from the proposed action will contribute to cumulative effects in the action area. Therefore, our analysis considers 1) effects caused by specific future non-federal activities in the action area; 2) effects in the action area caused by future non-federal activities in the Columbia basin.

Future upland development activities lacking a federal nexus are expected to result in increased pollution-generating impervious surface, runoff, and non-point source discharges. Population growth in Clark and Multnomah Counties are likely to remain high, which will require greater development to support and sustain this trend. State, county, and city regulations should minimize and mitigate for the adverse effects of this development so that the overall environmental quality of the action area remains constant, albeit degraded relative to its restored condition.

The legacy of resource-based industries (e.g., agriculture, hydropower facilities, timber harvest, fishing, and metal and gravel mining) caused long-lasting environmental changes that harmed ESA-listed species and their critical habitats. Stream channel morphology, roughness, and cover, estuarine rearing habitats, wetlands, floodplains, riparian areas, water quality, fish passage, and habitat refugia have been degraded throughout the LCR basin. Those changes reduce 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.

While widespread degradation of aquatic habitat associated with intense natural resource extraction is no longer common, ongoing land management actions are likely to continue to adversely affect the estuary and delay natural recovery of aquatic habitat in the CR basin including the action area. This trend is somewhat countered by non-federal aquatic habitat restoration occurring in the LCR. The Lower Columbia River Estuary Partnership has over 100 regional partners in the LCR and has completed 284 projects with a total of 35,342 acres of habitat restored (LCREP, 2024). Projects include land acquisitions and conservation easements, adding large logs to streams to create fish habitat, planting trees to shade and cool streams, and removing barriers to fish passage. Still, when considered together, the net cumulative effects are likely to have an adverse effect on ESA-listed fish within the action area.

2.7. Integration and Synthesis

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

2.7.1. ESA Listed Species

Salmon and steelhead

Eleven of the salmon and steelhead species addressed by this consultation are "threatened." Upper Columbia River spring-run Chinook salmon, and Snake River sockeye salmon are "endangered". The status of the constituent populations ranges from very high risk to moderate risk of extirpation. The total abundance of all salmon and steelhead species is very low relative to historical levels. Their historic range and spatial structure are curtailed or modified. Multiple limiting factors prevent natural fish production from significantly increasing productivity, abundance and diversity. All individuals from populations of these listed species are likely to move through the action area at some or multiple points during their life history.

The environmental baseline includes developed urban areas, land use practices, degraded estuarine and nearshore habitat, degraded floodplain connectivity and function, altered streamflow and channel complexity, reduced large wood and substrate recruitment, predation, and contaminants. BB 0.28 construction effects will be present for two July to November work windows and the dike will exist for decades. Climate change is likely to include greater variability in Pacific Northwest river systems, more frequent droughts, larger floods and higher temperatures. Estuaries and oceans will have higher water temperatures, decreased salinity and increased acidity. The (non-federal) cumulative effects in the coming decades are expected to be incrementally negative for habitat conditions. Changes to the projects effects due to climate change are likely to be limited to the water surface elevation of the rock dike. The effectiveness of the notches may change through time as fish encounter drought conditions that were not accounted for in the design.

We added the effects of the proposed action on species to determine the likely changes in abundance, productivity, spatial structure, and genetic diversity of the affected species and the implication for species viability. Endangered UCR spring-run Chinook salmon and SR sockeye salmon along with threatened SR spring/summer-run Chinook salmon, SR fall-run Chinook salmon, MCR steelhead, UCR steelhead and SRB steelhead will pass through the action area as larger juveniles, use a greater variety of (deeper) habitats, and swim faster than fish that originate in the Lower Columbia River and Willamette River. These species will be less exposed to the construction noise and turbidity effects than Lower Columbia origin fish. LCR and UWR Chinook, LCR and WR steelhead, LCR coho and CR chum salmon rely more on the shallow water in the action area and thus have more exposure to the effects of the action. However, the temporary noise, handling, and turbidity during construction, added to the environmental baseline and the cumulative effects of climate change, are not likely to appreciably reduce the current abundance of any population of any SR, CR, or UWR salmon or steelhead species.

Noise generated from driving pile with an impact hammer will occur during a small window when these species and life histories are least likely to be present and are likely to occur within a single season. Dredging will cause turbidity and diminish benthic forage, but the spatial extent is largely isolated to the project area and limited to two work windows over two years (turbidity) and up to 5 years for full recovery of the benthic habitats. Enduring effects associated with the replacement dike will negatively affect juvenile Chinook, chum, coho, and sockeye. The new rock dike will impede the migration along nearshore migration routes and subject these species life histories to increased predation by diverting them to deeper water and funneling them through notches, which are reasonably likely to become hot-spots for predators. However, the footprint of the rock structure will not expand from the current structure and occupies a small proportion of the lower Columbia River estuary. Notches designed into the structure are wide providing an opportunity for juvenile fish to evade predators that might be present. Additionally, removing the wooden piles will greatly reduce avian predation that is known to occur at the project site. When the effects of the action are added to the environmental baseline, cumulative effects, and the effects climate change, they are not likely to appreciably reduce the current abundance of any population of any SR, CR, or UWR salmon species.

Green sturgeon

Green sturgeon are listed as threatened based on a decline from historic abundance, and low productivity. The main limiting factor to survival and recovery is that potential spawning habitat in the Sacramento River is not being used. There are between 800 and 1,800 spawning adults in the Southern DPS of green sturgeon. Sub adult and adult green sturgeon migrate to the LCR estuary action area to forage during the summer and early fall, and the action area is critical habitat for green sturgeon. Green sturgeon are likely to be exposed noise and turbidity from dredging and pile driving but we do not expect pile driving to injure or kill any individuals in the action area. When the proposed action is added to the environmental baseline and to cumulative effects from climate change, we do not expect it to reduce green sturgeon abundance, productivity, spatial structure or diversity or to alter the trajectory of their survival or recovery.

A very small amount of green sturgeon food supply may be temporarily disrupted by proposed action dredging at the material and equipment offloading facility but the conservation value of the action area critical habitat will not be diminished. Long-term effects associated with the project are not anticipated for green sturgeon.

Humpback whales

The Mexico DPS of humpback whales is threatened and the Central America DPS is endangered. The main limiting factors to recovery are entanglement in fishing gear and vessel strikes. The Corps determined the proposed action is likely to adversely affect the two DPSs of humpback whales, and has proposed to halt work if whales enter the project area. Humpback whales forage along the Oregon-Washington coast in the summer and fall and may enter the action area to be exposed to injurious pile driving sound pressure levels. Humpback whales have entered the action area previously during the August 1 to November 30 in-water work window and two humpback whales were observed in the action area during the Sand Island test pile project. Behavioral responses of humpback whales to pile driving and removal at the West Sand Island project sites are expected to be mild, short term, and temporary. Any impacts on humpback whale prey that would occur during the Corps' planned activity would have at most short-term effects on foraging of individual whales, and likely no effect on the population of humpback whales as a whole. Therefore, indirect effects on humpback whale prey during the construction are not expected to be substantial, and these insubstantial effects would therefore be unlikely to cause substantial effects on the humpback whales themselves. NMFS does not anticipate that serious injury or mortality would occur as a result of the Corps' proposed action. When the effects of the proposed action are added to the environmental baseline, cumulative effects, and effects from climate change, we do not expect them to reduce Mexico or Central America DPS humpback whale abundance, productivity, spatial structure or diversity. Long-term impacts from the project are not expected to affect humpback whales.

2.7.2. Critical Habitat

Columbia River estuary critical habitat has high conservation value because of the critical function it serves to species using it for migration to and from spawning areas and for rearing. The critical habitat quality and quantity is limited by water quality, altered hydrology, lack of floodplain connectivity and shallow-water habitat, and lack of complex habitat to provide forage and cover. All of these specific factors of decline are part of the systemic degradation of habitat features across the habitat for these ESA listed species, including the action area. Additionally, when considering cumulative effects, future development, even if limited, together with climate change, has the potential to further diminish Columbia River estuary habitat.

The effects of the action on critical habitat are both positive and negative. Negative effects on PBFs are restricted migration pathways for nearshore dependent species, including Chinook, coho, chum, and sockeye salmon. The proposed action will also increase the risk of piscivorous predation, which reduces the quantity and quality of rearing and migration habitat for these early life history stages of salmon. This action is expected to impact critical habitat for decades. The positive effects on PBFs include a decrease in the amount of avian predation on juvenile salmonids.

Climate change is likely to adversely affect the overall conservation value of Lower Columbia River Chinook salmon, Upper Willamette River Chinook salmon, Upper Columbia River spring Chinook salmon, Snake River spring/summer Chinook salmon, Snake River fall Chinook salmon, Lower Columbia River coho salmon, Columbia River chum salmon, Snake River Sockeye salmon, Lower Columbia River steelhead, Middle Columbia River steelhead, Upper Columbia River steelhead, Upper Willamette River steelhead, Snake river Basin steelhead, Green sturgeon, or their designated critical habitats. The adverse effects are likely to include, but are not limited to, temporary habitat diminishment, including reduction in benthic forage, turbidity, and noise; and enduring diminishment of fish passage and predation risk. The magnitude and severity of these effects will vary from year to year. The long-term effects of the proposed action will last for decades and will overlap with the effects of climate change. However, the proposed action’s effects are unlikely to exacerbate the effects of climate change in the action area or critical habitat because the dike’s effects on the environmental stressors (water quantity, fish migration obstruction, and predation) most likely to be affected by climate change will be minor and not meaningful.

The environmental baseline is degraded by past land and waterway management activities including agriculture, forestry, grazing, road building and maintenance, urbanization, dam construction and operation and maintenance, and commercial vessel traffic will continue to degrade aquatic habitat for ESA-listed salmonids and green sturgeon in the action area. These activities will continue to impact water quality by increasing water temperatures, adding chemicals to the water (stormwater contaminants associated with urbanization and recreational boating), increasing sedimentation, increasing predation on these species. Each of these activities has contributed to a myriad of interrelated factors for the decline in quality and function of critical habitat PBFs essential for the conservation of ESA-listed salmonids and green sturgeon in the action area and lower Columbia River estuary.

Non-project related land and waterway management activities including agriculture, forestry, grazing, road building and maintenance, urbanization, and reservoir recreation will continue to degrade critical habitat for ESA-listed salmonids and green sturgeon in the action area. Impacts associated with these activities are ongoing and likely to continue to have a depressive effect on critical habitat features essential to support the LCR Chinook salmon, UWR Chinook salmon, UCR spring Chinook salmon, SR spring/summer Chinook salmon, SR fall Chinook salmon, LCR coho salmon, CR chum salmon, SR Sockeye salmon, LCR steelhead, MCR steelhead, UCR steelhead, UWR steelhead, SR Basin steelhead, and Green sturgeon critical habitat PBFs. Therefore, we expect the quality and function of in the action area will continue to be negatively impacted because of cumulative effects. The action area is not included within the Mexico DPS or Central America DPS designated critical habitat for humpback whales.

Adverse effects to the quality and function of critical habitat PBFs from this project will take place in a small part of the Columbia River. Any effect on water quality construction is temporary and does not substantially alter the function of the critical habitat at the action area scale, or at the 5^{th}-level HUC scale. When effects of the action are added to the environmental baseline and cumulative effects, and effects from climate change, the quality of critical habitat PBFs in the action area are not expected change significantly enough to alter the conservation value of critical habitat for any affected species.

2.8. Conclusion

After reviewing and analyzing the current status of the listed species and critical habitat, the environmental baseline within the action area, the effects of the proposed action, the effects of other activities caused by the proposed action, and the cumulative effects, it is NMFS' biological opinion that the proposed action is not likely to jeopardize the continued existence of: Lower Columbia River Chinook salmon, Upper Willamette River Chinook salmon, Upper Columbia River spring Chinook salmon, Snake River spring/summer Chinook salmon, Snake River fall Chinook salmon, Lower Columbia River coho salmon, Columbia River chum salmon, Snake River Sockeye salmon, Lower Columbia River steelhead, Middle Columbia River steelhead, Upper Columbia River steelhead, Upper Willamette River steelhead, Snake river Basin steelhead, Green sturgeon, Humpback whale-Central America DPS, Humpback whale Mexico DPS or destroy or adversely modify their designated critical habitat.

2.9. Incidental Take Statement

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

The marine mammal portion of this ITS is a preliminary statement. It will become final and effective upon the issuance of the authorization under section 101(a)(5) of the Marine Mammal Protection Act and NMFS's written confirmation to the Federal agency and applicant, for the duration of the authorization and with relevant revisions per the final authorization.

2.9.1. Amount or Extent of Take

As described below, accurately quantifying the number of fish or whales harmed by several of these pathways is not possible because injury and death of individuals in the action area is a function of habitat quality, competition, predation, and the interaction of processes that influence genetic, population, and environmental characteristics. These biotic and environmental processes are highly variable and interact in ways that may be random or directional, and may operate across broad temporal and spatial scales. The precise distribution and abundance of fish and whales within the action area, at the time of the action are not a simple function of the quantity, quality, or availability of predictable habitat resources within that area. Rather, the distribution and abundance of fish and whales also show wide, random variations due to biological and environmental processes operating at much larger demographic and regional scales. Thus, the distribution and abundance of fish and whales within the action area cannot be attributed entirely to habitat conditions, nor can we precisely predict the number of fish or whales that are reasonably certain to be injured or killed either directly or if their habitat is modified or degraded by actions that will be completed under the proposed action. It may be possible to observe and document injured or killed individual fish, but not all instances of death or injury are likely to be observed during construction. Except where some fish salvage efforts are employed where the number of fish handled, injured, or killed will be recorded, it is not practical or realistic to attempt to identify and monitor the number of fish taken by the other pathways described.

In cases such as this, where observing and quantifying a number of fish and whales taken as a result of the proposed action is not possible, we use take surrogates indicators that rationally reflect the incidental take caused by the proposed action. We identified three separate surrogates to serve as indicators for the extent of take caused by the proposed action: (1) the footprint of the rock dike; (2) the extent of visible suspended sediment plumes; and (3) length and frequency of disturbance from pile driving noise. Take associated with fish salvage does not require a take surrogate as mortality will be measured and reported during fish salvage efforts.

1. The footprint of the rock dike area is associated with take due to injury, death, or harm from work area isolation, passage delay, and fish capture. That harm cannot reliably be monitored and quantified, as only some incidences of capture and mortality can be observed while other harm cannot be reliably observed. Therefore, NMFS will rely on a two-factor surrogate consisting of the spatial extent of the rock dike area footprint, as well as the largest spatial extent of temporary sheet pile enclosure. The footprint of rock dike area and the sheet pile enclosure required for the work are directly related to the extent of take because the extent of fish exposed and harmed by the action increases with the size of the area and the duration of the action. Based on information provided in the biological assessment and correspondence with the Corps, there is likely to be approximately 206,000 sq. ft. of rock dike covering the substrate for decades. The temporary sheet pile enclosure will occupy a footprint of 5,000 sq. ft. on nearshore benthic habitat. NMFS anticipates that this enclosure will be installed from the beginning of the year one in-water work window until the end of the second in-water

work window. The spatial extent of the structures can be reliably measured and monitored because (1) approximately 206,000 sq. ft. is the measurable footprint of rock dike area; (2) the sheet pile enclosure is a measurable footprint.

2. Take occurring as a result of sediment released as part of the proposed action, including the area dredged to accommodate the enclosure, and rock placed to construct the rock dike, cannot be observed or measured and also requires a surrogate. The extent of take associated with the release of sediment correlates directly to the extent of suspended sediment plumes caused by the construction activities, which in turn correlates to the distance of any visible sediment plume, because the extent of the plume (and its visible portion) is directly related to the number of fishes exposed to the harm associated with the take pathway. Based on the location of anticipated construction events, the surrogate measure of take is any turbidity event which exceeds 10% above natural stream turbidities, and which creates a visible plume of this excess turbidity extending not more than 600 feet and lasting no longer than 4 hours. This extent of turbidity can be reliably measured and monitored by visual monitoring or using a turbidimeter, and this monitoring is expected to occur as part of the reporting requirements in the terms and conditions below.

3. Twelve marker piles will be installed using a vibratory hammer and an impact hammer. Each pile will require the use of an impact hammer to install half of each pile with the other half requiring the use of a vibratory hammer. The Corps believes this is a conservative estimate and that impact driving may constitute about 25% of the pile driving as has occurred in similar locations of the Lower Columbia River estuary. As described above, impact hammers impact fish and whales to the greatest extent among the proposed actions. Each of the 12 marker piles require 225 strikes with an impact hammer to imbed the pile to depth. This activity causes take via harassment associated with the resulting noise and vibrations. Because these forms of harassment cannot be observed or quantified, we will rely on a surrogate measure of take in the form of the number of strikes needed to complete the installation. The number of strikes can be reliably monitored as part of the reporting requirements, which will document all construction activities, including the dates on which they occurred.

2.9.2. Effect of the Take

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

2.9.3. Reasonable and Prudent Measures

"Reasonable and prudent measures" refer to those actions the Director considers necessary or appropriate to minimize the impact of the incidental take on the species (50 CFR 402.02).

1. Minimize incidental take caused by turbidity, fish salvage, and pile driving.

2. Minimize incidental take associated with post-construction operations by ensuring development and implementation of a comprehensive monitoring and reporting program conducted by the Corps.

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

1. The following terms and conditions implement reasonable and prudent measure 1:

    In-water work window: Work must be completed within the August 1 – November 30. If work cannot be completed within the work window, the Corps shall coordinate as soon as practicable, with NMFS and ODFW to determine next steps without guarantee of extension of ESA coverage.

    Soft start procedures for impact pile driving: NMFS understands the majority of pile driving will use a vibratory hammer; however, impact hammer will be used install the marker piles. When initiating impact pile driving activity, contractors will be required to provide an initial set of strikes from the hammer at reduced percent energy, each strike followed by no less than a 30-second waiting period. This procedure will be conducted a total of three times before impact pile driving begins. This can help increase distance between fish and marine mammals that may be affected by noise created by impact pile driving and the source of the sound.

    Use a bubble curtain to attenuate impact pile driving noise: Marker piles will be installed using an impact hammer due to the presence of the rock dike. Bubble curtains can buffer sound levels and decrease the likelihood that fish will be harmed. The Corps will ensure the contractor will employ bubble curtains to partially attenuate noise where feasible and effective.

    Fish salvage:
    Avoid trapping fish in the sheet pile enclosure by installing the deeper sheet piles last, if possible. Avoid trapping fish in the sheet pile enclosure with declining depths as the tide recesses, which can dewater the enclosure and increase mortality risk. Employ seine nets

to herd fish from the sheet pile enclosure prior to closing off the structure with the last sheet piles if the shallow sheet piles are the last to be installed.

Turbidity Control and Monitoring:
The Corps must ensure the applicant implement BMPs to minimize turbidity during in-water work. Any activity that causes turbidity to exceed 10% above natural stream turbidities is prohibited except as specifically provided below:

a) Turbidity monitoring must be conducted and recorded as described below. Monitoring must occur at two-hour intervals each day when in-water work is being conducted. A properly calibrated turbidimeter is required unless another monitoring method is proposed and authorized by DEQ.
   i) Representative Background Point: The Applicant must take and record a turbidity measurement every two hours during in-water work at an undisturbed area. A background location shall be established at a representative location approximately 100 feet up-current of the in-water activity unless otherwise authorized by DEQ. The background turbidity, location, date, tidal stage (if applicable) and time must be recorded immediately prior to monitoring down-current at the compliance point described below.
   ii) Compliance Point: The Applicant must monitor every two hours. A compliance location shall be established at a representative location approximately 100 feet down-current from the disturbance at approximately mid-depth of the waterbody and within any visible plume. The turbidity, location, date, tidal stage and time must be recorded for each measurement.

b) Compliance: The Applicant must compare turbidity monitoring results from the compliance points to the representative background levels taken during each two – hour monitoring interval. Consistent with DEQ Nationwide Permit #3, short term exceedances are allowed as follows:

MONITORING WITH A TURBIDIMETER EVERY 2 HOURS	
Turbidity Level	**Restrictions to Duration of Activity**
0 to 4 NTU above background	No Restrictions
5 to 29 NTU above background	Work may continue maximum of 4 hours. If turbidity remains 5-29 NTU above background, stop work and modify BMPs. Work may resume when NTU is 0-4 above background.
30 to 49 NTU above background	Work may continue maximum of 2 hours. If turbidity remains 30-49 NTU above background, stop work and modify BMPs. Work may resume when NTU is 0-4 above background.
50 NTU or more above background	Stop work immediately and inform DEQ

b) Reporting:
   i) Record all turbidity monitoring required by subsections (a) and (b) above in daily logs which must include: calibration documentation; background NTUs; compliance point NTUs; comparison of the points in NTUs; and location; date; and time for each reading.
   ii) A narrative must be prepared discussing all exceedances with subsequent monitoring, actions taken, and the effectiveness of the actions. The Corps must ensure the applicant make available copies of daily logs for turbidity monitoring to regulatory agencies including DEQ, USACE, NMFS, USFWS, and ODFW upon request.
   iii) Keep records on file for the duration of the permit cycle.

b) BMPs to Minimize In-stream Turbidity: The Corps must ensure the applicant implement the following BMPs, unless accepted in writing by NMFS:
   i) Sequence/Phasing of work – The Corps must ensure the applicant schedules work activities so as to minimize in-water disturbance and duration of in-water disturbances.
   ii) Bucket control - All in-stream digging passes by excavation machinery and placement of fill in-stream using a bucket must be completed so as to minimize turbidity. All practicable techniques such as employing an experienced equipment operator, not dumping partial or full buckets of material back into the wetted stream, adjusting the volume, speed, or both of the load, or using a closed-lipped environmental bucket must be implemented;
   iii) The Corps must ensure the applicant limits the number and location of stream-crossing events. Establish temporary crossing sites as necessary at the least sensitive areas and amend these crossing sites with clean gravel or other temporary methods as appropriate;
   iv) Machinery may not be driven into the flowing channel, unless authorized in writing by NMFS; and
   v) Excavated material must be placed so that it is isolated from the water edge or wetlands, and not placed where it could re-enter waters of the state uncontrolled.
   vi) Containment measures such as silt curtains, geotextile fabric, and silt fences must be in place and properly maintained in order to minimize in-stream sediment suspension and resulting turbidity.

2. The following terms and conditions implement reasonable and prudent measure 2:

Monitoring and Reporting:

a) **Fish Passage**. During the first spring (February through May) following the construction of the notches make visual observations of juvenile salmonids using or avoiding the rock dike notches.

b) **Project Completion Report**. The Corps will submit, or ensure that the permittee submits, a completion report portion to the NMFS mailbox (projectreports.wcr@noaa.gov) within 60 days of the end of construction for the authorized project. The Project Completion Report will consist of the following:

i) Actual Start and End Dates for the Completion of In-water Work;
ii) Turbidity Monitoring/Sampling Records;
iii) Fish passage "notch" monitoring results;
iv) As built drawings;
v) Habitat conditions before and after the action is completed;
vi) Summarized results of pollution and erosion control inspections, including any erosion control failure, contaminant release, and correction effort;
vii) Describe turbidity monitoring (by turbidimeter) including dates, times and location of monitoring and any exceedances and steps taken to reduce turbidity observed;
viii) Fish removal report, including:
    (1) Number of fish by species observed;
    (2) Number of fish physically captured in netting
    (3) Number of mortalities
    (4) Dates and times of fish isolation efforts
ix) Pile driving report, including:
    (1) Number and dimensions of round piles installed
    (2) Number of piles and average installation time using a vibratory hammer
    (3) Number of piles and average installation time using an impact hammer
    (4) Average number of strikes per pile using an impact hammer

2.10. Reinitiation of Consultation

This concludes formal consultation for Baker Bay West Pile Dike Repair Project.

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

2.11. "Not Likely to Adversely Affect" Determinations

The USACE analyzed the direct effects and critical habitat effects of the proposed action on:

1. Southern DPS eulachon
2. Southern Resident killer whales
3. Leatherback sea turtles
4. Sunflower sea star

Eulachon
The USACE analyzed the direct temporary construction effects and the direct permanent rock dike effects of the proposed action to eulachon. They determined that eulachon are not exposed to the temporary construction effects because they are not present in the action area during the July to November work window so the effects are discountable. They determined that covering 0.45 acres of sandy benthic habitat with the rock dike is an insignificant loss of LCR estuary benthic habitat because there are still 100s of thousands of acres of sandy benthic habitat in the estuary.

The USACE analyzed the temporary construction effects and the permanent dike effects of the proposed action on eulachon estuarine migration corridor critical habitat PBFs of obstruction and prey. They determined that the pile driving noise and turbidity obstruction to migration takes place when eulachon are not present and are discountable. The dike itself is not expected to be a migration barrier for eulachon. Therefore, effects of the proposed action are insignificant.

Adult eulachon migrate through the action area from December through April but are not present to be exposed to the effects of the proposed action during the July to November work window. Eulachon larvae are carried downstream through the action area from February through early June but are also not present to be exposed to the effects of the proposed action during the July to November work window. Therefore, we concur that the construction effects of the proposed action on eulachon are discountable.

SRKW
The USACE analyzed the direct effects of pile driving noise, vessel and construction equipment noise and vessel strikes to SRKW. They determined that all of these direct effects are discountable because SRKW have not been observed entering the mouth of the Columbia River and are unlikely to be off the Oregon Washington coast during the work window.

The USACE analyzed the effects of the proposed action on the SRKW critical habitat PBF of prey and determined that any salmon injured or killed by pile driving would have an insignificant effect on the SRKW prey base. The proposed action would kill far too few Chinook salmon to have any impact on SRKW prey.

Leatherback sea turtles
The USACE analyzed the direct effects of the proposed action on leatherback sea turtles. They determined that leatherback sea turtles are extremely unlikely to be in the action area, the effects are discountable. The USACE analyzed the effect of the proposed action on leatherback sea turtle critical habitat PBF prey species and determined that the effects are determined that the effects are insignificant. However, there is no spatial overlap with effects of the action and leatherback sea turtle critical habitat and the proposed action will have no effect on the critical habitat for this species.

Leatherback sea turtles primarily nest in Indonesia, Papau New Guinea and Solomon Islands. They travel across the Pacific Ocean past Hawaii to forage with some reaching the outer coast of Oregon and Washington during the late summer and fall. They have not been observed to enter the Columbia River action area and the effects of the proposed action are discountable.

2.12. Conference on Sunflower Sea Star

The USACE analyzed the direct effects of the proposed action on sunflower sea star and determined that because they are rare south of Cape Flattery and because the 0.45 acres of benthic habitat covered by the rock dike is such a small fraction of the LCR estuary area, the effects are discountable or insignificant as described below.

The action would disturb a relatively small amount of benthic habitat. Given regionally documented low sea star density, we conclude it is extremely unlikely that any sunflower sea star would be exposed to the construction disturbance based on their sparse distribution and, therefore, the construction effects would be discountable. Furthermore, as habitat generalists, we expect sea stars would be able to successfully use much of the habitat that is disturbed by the project. Thus, any long-term effects on sunflower sea stars from project-induced changes in habitat would be insignificant.

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 associated physical, chemical, and biological 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 may result from actions occurring within EFH or outside of it and may include direct, indirect, site-specific or habitat-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 (50 CFR 600.905(b))].

3.1. EFH Affected by the Proposed Action

The proposed project occurs within EFH for various federally managed fish species within the Pacific Coast groundfish fishery management plan (Pacific Fishery Management Council 2023), Coastal pelagic species fishery management plan (Pacific Fishery Management Council (PFMC) 2023) and the Pacific Coast salmon fishery management plan (Pacific Fishery Management Council (PFMC) 2024).

In addition, the project occurs within, or in the vicinity of the Lower Columbia River Estuary (LCRE) which is designated as a habitat area of particular concern (HAPC) for various federally managed fish species within the groundfish and Pacific Coast Salmon FMPs. HAPC are described in the regulations as subsets of EFH which are rare, particularly susceptible to human-induced degradation, especially ecologically important, or located in an environmentally stressed area. Designated HAPC are not afforded any additional regulatory protection under the MSA; however, federal projects with potential adverse impacts on HAPC will be more carefully scrutinized during the consultation process.

3.2. Adverse Effects on EFH

NMFS determined the proposed action would adversely affect EFH as follows:

1. Noise and turbidity during steel pipe pile and sheet pile driving temporarily degrades water quality until the pile driving stops and conditions return to normal.
2. Suspended sediment during dredging temporarily degrades water quality until the dredging stops and the water quality returns to normal.
3. Habitat impacts from the rock dike including shifts in macroinvertebrate community structure.

These adverse effects are identical to the adverse effects in the accompanying ESA biological opinion and are minimized to the greatest extent practicable by the best management practices in the proposed action. Therefore, NMFS has no additional EFH conservation recommendations to provide at this time. This concludes the EFH consultation.

3.3. Supplemental Consultation

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

4. DATA QUALITY ACT DOCUMENTATION AND PRE-DISSEMINATION REVIEW

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

4.1. Utility

Utility principally refers to ensuring that the information contained in this consultation is helpful, serviceable, and beneficial to the intended users. The intended user of this opinion is the USACE. Individual copies of this opinion were provided to the USACE. The document will be available at the NOAA Library Institutional Repository [https://repository.library.noaa.gov/welcome]. The format and naming adhere to conventional standards for style.

4.2. Integrity

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

4.3. Objectivity

Information Product Category: Natural Resource Plan

Standards: This consultation and supporting documents are clear, concise, complete, and unbiased; and were developed using commonly accepted scientific research methods. They adhere to published standards including the NMFS ESA Consultation Handbook, ESA regulations, 50 CFR 402.01 et seq., and the MSA implementing regulations regarding EFH, 50 CFR part 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, if applicable*], and reviewed in accordance with West Coast Region ESA quality control and assurance processes.

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