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-2022-01674

February 17, 2023

William D. Abadie
Chief, Regulatory Branch
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 Port of Astoria East Mooring Basin Maintenance Dredging, Baker Bay — Columbia River, (HUC:170800060500) (NWP-2021-34)

Dear Mr. Abadie:

Thank you for your letter of July 8, 2022, requesting initiation of consultation with NOAA's National Marine Fisheries Service (NMFS) pursuant to Section 7 of the Endangered Species Act of 1973 (ESA) (16 U.S.C. 1531 et seq.) for the Port of Astoria East Mooring Basin Maintenance Dredging (NWP-2021-34). Thank you, also, for your request for consultation pursuant to the essential fish habitat (EFH) provisions in Section 305(b) of the Magnuson-Stevens Fishery Conservation and Management Act (16 U.S.C. 1855(b)) for this action.

In the attached biological opinion, NMFS concludes that the proposed action is not likely to jeopardize the continued existence of:

- *Oncorhynchus tshawytscha*: Lower Columbia River (LCR) Chinook salmon, Upper Columbia River (UCR) spring-run Chinook salmon, Upper Willamette River (UWR) spring-run Chinook salmon, Snake River (SR) spring/summer-run Chinook salmon, SR fall-run Chinook salmon;
- *O. keta*: Columbia River (CR) chum salmon;
- *O. kisutch*: LCR coho salmon;
- *O. nerka*: SR sockeye salmon;
- *O. mykiss*: Middle Columbia River (MCR) steelhead, UCR steelhead, UWR steelhead, Snake River Basin (SRB) steelhead; or
- *Thaleichthys pacificus*: Southern DPS Pacific eulachon.

We conclude that the proposed action is also not likely to result in the destruction or adverse modification of their critical habitats.

We also concluded that the southern DPS of green sturgeon (*Acipenser medirostris*) are not likely to be adversely affected, and our analysis appears in section 2.10 of this document.

As required by Section 7 of the ESA, NMFS is providing an incidental take statement with the biological opinion. The incidental take statement describes reasonable and prudent measures NMFS considers necessary or appropriate to minimize the impact of incidental take associated with this action. The take statement sets forth nondiscretionary terms and conditions, including reporting requirements, that the U.S. Army Corps of Engineers (USACE) or any applicant must comply with to carry out the reasonable and prudent measures. Incidental take from actions that meet these terms and conditions will be exempt from ESA's prohibition against the take of listed species.

This document also includes the results of our analysis of action's likely effects on essential fish habitat (EFH) pursuant to Section 305(b) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA). We concluded that the proposed action would adversely affect EFH of Pacific Coast salmon and Pacific Coast groundfish, and have included three conservation recommendations to avoid, minimize, or otherwise offset potential adverse effects on EFH. Section 305(b) (4) (B) of the MSA requires Federal agencies to provide a detailed written response to NMFS within 30 days after receiving these recommendations.

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

If the response is inconsistent with the EFH conservation recommendations, the USACE must explain why the recommendations will not be followed, including the scientific justification for any disagreements over the effects of the action and the recommendations.

Please contact Jayvoni Francis, of the Oregon Washington Coastal Office in Lacey, Washington, at jayvoni.francis@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: Kinsey Friesen, USACE
Katharine Mott, USACE
Melody White, USACE

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

Port of Astoria East Mooring Basin Maintenance Dredging
Baker Bay — Columbia River, (HUC:170800060500)
(NWP-2021-34)

NMFS Consultation Number: WCRO-2022-01674

Action Agency: US Army Corps of Engineers — Portland District

Affected Species and NMFS' Determinations:

ESA-Listed Species	Status	Is Action Likely to Adversely Affect Species?	Is Action Likely to Jeopardize the Species?	Is Action Likely to Adversely Affect Critical Habitat?	Is Action Likely to Destroy or Adversely Modify Critical Habitat?
Lower Columbia River (LCR) Chinook salmon (*Oncorhynchus tschawtscha*)	Threatened	Yes	No	Yes	No
Upper Willamette River (UWR) Chinook salmon	Threatened	Yes	No	Yes	No
Upper Columbia River (UCR) spring-run Chinook salmon	Endangered	Yes	No	Yes	No
Snake River spring/summer-run Chinook salmon	Threatened	Yes	No	Yes	No
SR fall-run Chinook salmon	Threatened	Yes	No	Yes	No
LCR coho salmon (*O. kisutch*)	Threatened	Yes	No	Yes	No
SR sockeye salmon (*O. nerka*)	Endangered	Yes	No	Yes	No
CR chum salmon (*O. keta*)	Threatened	Yes	No	Yes	No
LCR steelhead (*O. mykiss*)	Threatened	Yes	No	Yes	No
UWR steelhead	Threatened	Yes	No	Yes	No
Middle Columbia River (MCR) steelhead	Threatened	Yes	No	Yes	No
UCR steelhead	Threatened	Yes	No	Yes	No
Snake River Basin (SRB) steelhead	Threatened	Yes	No	Yes	No
Southern DPS of green sturgeon (*Acipenser medirostris*)	Threatened	No	No	Yes	No
Southern DPS of Pacific eulachon (*Thaleichthys pacificus*)	Threatened	Yes	No	Yes	No

Fishery Management Plan That Identifies EFH in the Project Area	Does Action Have an Adverse Effect on EFH?	Are EFH Conservation Recommendations Provided?
Pacific Coast Salmon	Yes	Yes
Pacific Coast Groundfish	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: February 17, 2023

TABLE OF CONTENTS

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 the Oregon Washington Coastal Office in Lacey, Washington.

1.2. Consultation History

This biological opinion is in response to the U.S. Army Corps of Engineers — Portland District (USACE) request for formal consultation on ESA listed species detailed in Table 1 below. The proposed maintenance dredging affects all salmon and steelhead listed and their critical habitat. The USACE also requested consultation on EFH for Pacific Coast salmon. Although the USACE did not request consultation on EFH for Pacific Coast groundfish, we know that some of these are present in a portion of the action area and provide an effects analysis in Section 3.

NMFS received the request for formal Section 7 and EFH consultation along with a memorandum for the service and a biological assessment (BA) on July 8, 2022. A sediment determination memorandum and project plan sheets were also contained in the BA. The USACE’s affects determination was likely to adversely affect (LAA) for all species.

- On September 1, 2022, NMFS received an inquiry about the status of the consultation.
- On October 5, 2022, NMFS notified USACE that the consultation package was complete and is initiating the consultation.
- On October 13, 2022, USACE confirmed a new project manager.
- On October 27, 2022, it was confirmed that Southern Resident killer whales or Humpback whales and their critical habitat were not included in the action agency’s request.

Table 1. List of species included in this consultation for the Port of Astoria East Mooring Basin Maintenance Dredging project.

ESU or DPS Species	Listing Notice	Listing Status	Critical Habitat Listing
LCR[a] Chinook salmon	6/28/2005; 70 FR 37160	Threatened	9/2/2005; 70 FR 52630
UWR[a] Chinook salmon	6/28/2005; 70 FR 37160	Threatened	9/2/2005; 70 FR 52630
UCR[a] spring-run Chinook salmon	6/28/2005; 70 FR 37160	Endangered	9/2/2005; 70 FR 52630
SR[a] spring/summer-run Chinook salmon	6/28/2005; 70 FR 37160	Threatened	10/25/1999; 64 FR 57399
SR fall-run Chinook salmon	6/28/2005; 70 FR 37160	Threatened	10/25/1999; 64 FR 57399
LCR coho salmon	6/28/2005; 70 FR 37160	Threatened	2/24/2016; 81 FR 9252
SR sockeye salmon	4/14/2014; 79 FR 20802	Endangered	12/28/1993; 58 FR 68543
CR[a] chum salmon	6/28/2005; 70 FR 37160	Threatened	9/2/2005; 70 FR 52630
LCR steelhead	1/5/2006; 71 FR 834	Threatened	9/2/2005; 70 FR 52630
UWR steelhead	1/5/2006; 71 FR 834	Threatened	9/2/2005; 70 FR 52630
MCR[a] steelhead	1/5/2006; 71 FR 834	Threatened	9/2/2005; 70 FR 52630
UCR steelhead	1/5/2006; 71 FR 834	Threatened	9/2/2005; 70 FR 52630
SRB[a] steelhead	1/5/2006; 71 FR 834	Threatened	9/2/2005; 70 FR 52630
Southern DPS of green sturgeon	4/7/2006; 71 FR 17757	Threatened	10/9/2009; 74 FR 52300
Southern DPS of Pacific eulachon	3/18/2010; 75 FR 13012	Threatened	10/20/2011; 76FR 65324

Note: ESU = Environmentally Significant Unit; DPS = Distinct Population Segment

[a] LCR: Lower Columbia River; UCR: Upper Columbia River; SR: Snake River; UWR: Upper Willamette River; CR: Columbia River; MCR: Middle Columbia River; SRB: Snake River Basin.

On July 5, 2022, the U.S. District Court for the Northern District of California issued an order vacating the 2019 regulations that were revised or added to 50 CFR part 402 in 2019 (“2019 Regulations,” see 84 FR 44976, August 27, 2019) without making a finding on the merits. On September 21, 2022, the U.S. Court of Appeals for the Ninth Circuit granted a temporary stay of the district court’s July 5 order. On November 14, 2022, the Northern District of California issued an order granting the government’s request for voluntary remand without vacating the 2019 regulations. The District Court issued a slightly amended order two days later on November 16, 2022. As a result, the 2019 regulations remain in effect, and we are applying the 2019 regulations here. For purposes of this consultation and in an abundance of caution, we considered whether the substantive analysis and conclusions articulated in the biological opinion and incidental take statement would be any different under the pre-2019 regulations. We have determined that our analysis and conclusions would not be any different.

1.3. Proposed Federal Action

Under the ESA, “action” means all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by Federal agencies (see 50 CFR 402.02). Under MSA, federal action means any action authorized, funded, or undertaken, or proposed to be authorized, funded or undertaken by a federal agency (50 CFR 600.910).

The USACE proposes to issue a permit under Section 10 of the Rivers and Harbors Act to the Port of Astoria (Port) to perform maintenance dredging within its East Mooring Basin (EMB) facility. This permit would also allow for in-water disposal of dredged sediment within the Columbia River (CR). The EMB has not been dredged in over a decade and sediment accumulation within the facility has exceeded safe mooring depths (Campbell, 2022). The EMB is used primarily to moor private fishing and recreational vessels. All portions of the proposed action are located along the south shore of the CR in Astoria, Oregon (Figure 1).

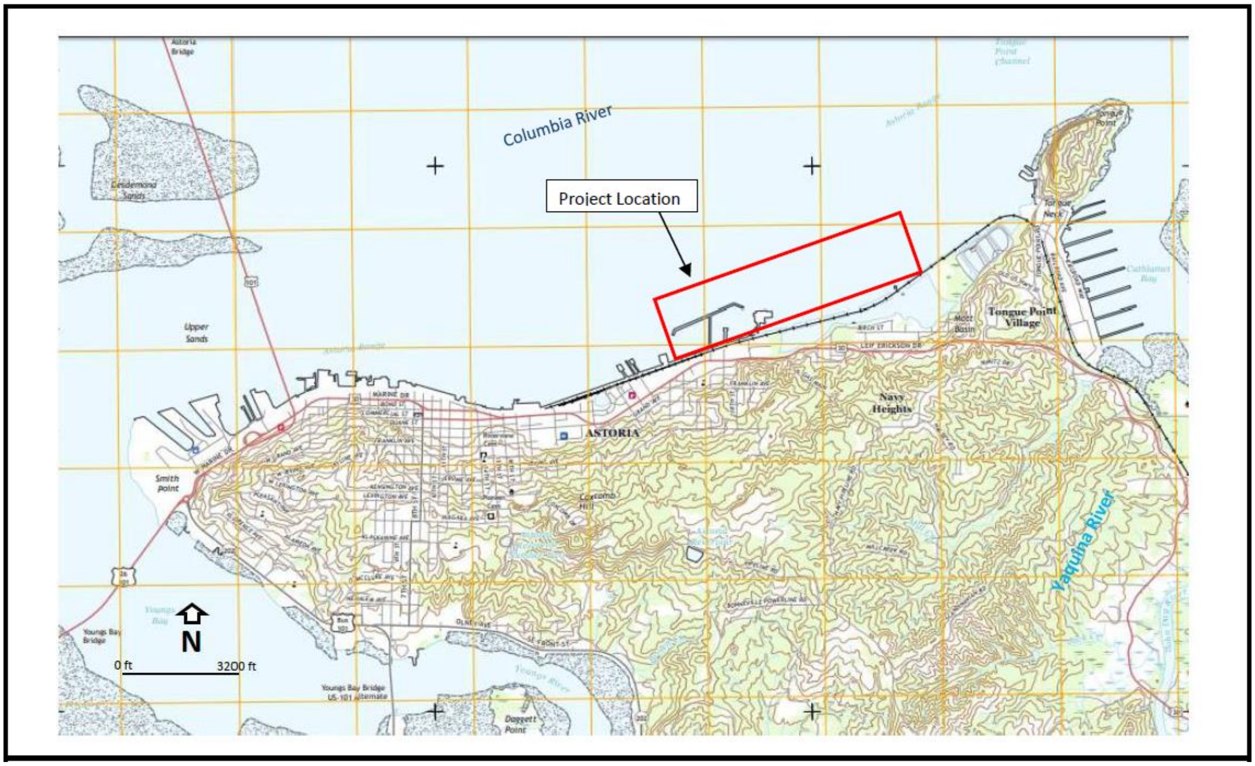

Figure 1. Port of Astoria maintenance dredging project location. Figure courtesy of Campbell Environmental LLC

The Port is requesting a 5-year permit to conduct maintenance dredging of a maximum of 144,350 total cubic yards of accumulated sediment over the course of 5 years (Campbell, 2022). The Port proposes to dredge an average of 28,000–35,000 cubic yards of sediment per year in order to maintain the required moorage depths. Dredging would occur for a maximum of 120 days per year. The proposed dredge prism is 23.3 acres at depths ranging from -5.0 to -20.0 feet mean-low-low-water (MLLW) (Table 2).

Table 2. Port of Astoria East Mooring Basin DMMUs, Depths, and Quantities

Proposed DMMUs	Area (acres)	Dredge Volume (cy)	Dredge Depth (MLLW)
1	10.0	62,195	-12 to -20
2	9.5	65,495	-12 to -20
3	3.8	16,658	-5 to -10
Total	**23.3**	**144,348**	

Note: DMMU = Dredge Material Management Unit; cy = cubic yard

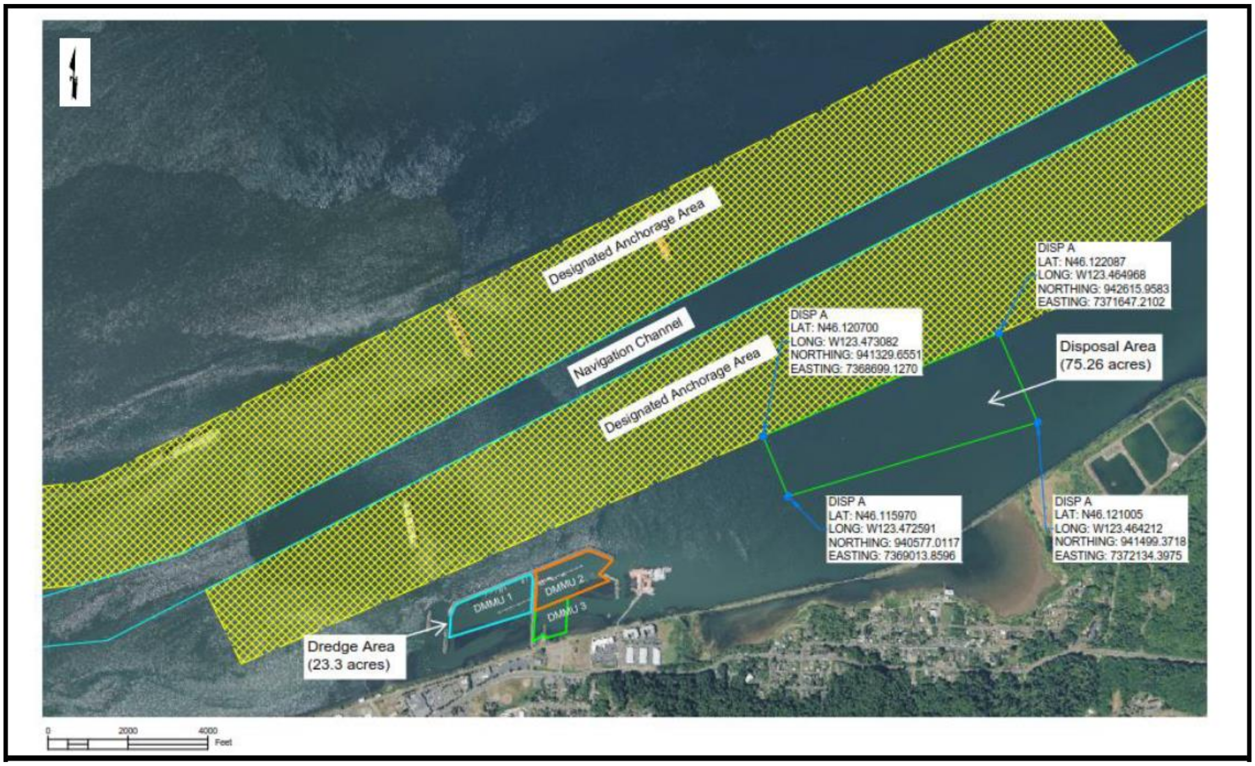

Figure 2. Port of Astoria maintenance dredging and disposal locations.

All resulting dredge material would be deposited in the flow lane of the CR at the disposal area approximately 2,000 feet from the dredge prism (Figure 2). The Portland Sediment Evaluation Team (PSET) reviewed the Sediment Characterization Report for the proposed dredging site and approved the associated dredge material for unconfined, aquatic placement (Campbell, 2022).

The Port proposes to conduct dredging using hydraulic suction operated from a floating barge. Dredged sediments would be discharged from a pipeline into the CR to the designated disposal location adjacent to the navigation channel.

Conservation measures as proposed within the BA submitted by the Port and their consultant Campbell Environmental LLC, have been incorporated into the proposed action to minimize adverse effects to ESA-listed species and their designated critical habitats (Campbell, 2022). These conservation measures include the following:

- All work conducted below the highest measured tide (HMT) of the CR would occur during the Oregon Department of Fish and Wildlife (ODFW) preferred in-water work window (IWWW) for the CR estuary (November 1–February 28), a period when ESA-listed species are less likely to be present within the project action area.
- All heavy equipment (i.e., crane) would access the project site via existing roadways and floating barges.
- All dredged materials and leave surface would be suitable and approved for in-water disposal based on the Sediment Evaluation Framework.

- All dredged sediment would be deposited in the flow lane of the CR, where it would be recruited by the next high flow event and provide aquatic habitat functions.
- Dredge material would be deposited primarily during the flood tide (including two hours prior to slack tide and one hour after slack tide) in the upper half of the water column to promote dispersal and prevent mounding.
- After each 10,000 cubic yards of material placement, the end of the discharge pipe shall be moved a minimum of 500–600 feet from its previous location. In addition, the location of the discharge pipe shall alternate from one side of the placement area to the other for each move.
- Proposed dredging would not alter the character, scope, or size of the project area.
- Operation of a hydraulic intake below the mudline, and/or slow operation of a clam shell or excavator would minimize the potential for entrainment during dredging activities.
- Where feasible, floating silt curtains would be placed around the in-water dredge area.
- A Pollution Control Plan (PCP) would be prepared by the contractor and carried out commensurate with the scope of the project that includes the following:
    - BMPs to confine, remove, and dispose of construction waste.
    - Procedures to contain and control a spill of any hazardous material.
- All conditions of ODEQ’s 401 Water Quality Certification would be followed.
- Only enough supplies and equipment to complete the project would be stored on site.
- All equipment would be inspected daily for fluid leaks, any leaks detected would be repaired before operation is resumed.
- Stationary power equipment operated within 150 feet of the CR would be diapered to prevent leaks.

The proposed action includes all dredging operations, moving and handling of the dredged material, and open-water disposal of that material. The purpose of this project is to accommodate current vessels rather than to increase vessel use. We determined there are no new long-term activities that would directly or indirectly affect ESA-listed species that would be considered actions caused by the proposed action. We have not included any actions other than those described above in our ESA or EFH analyses. Effects of existing vessel use of the EMB are part of the environmental baseline. No element of the action as we understand would cause additional vessel-related effects at this location.

1.4. 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 EMB is located within Baker Bay on the CR within the 12 digit, 6th field HUC 170800060500, at river mile 15.6. The action area includes the Port’s 23.3 acre EMB (dredge prism) and one 75.26 acre flow lane disposal site located approximately 2,000 feet east of the dredge prism (Figure 2). The action area also includes 100 feet around and 300 feet downstream of the proposed dredging and disposal areas. Suspended course grain sediments (e.g. gravel, and sand) are expected to produce turbidity throughout this additional area. There is also potential for turbidity to extend beyond 100 feet around and 300 feet downstream of the dredge and disposal

areas however, it is expected that turbidity extending beyond this distance would be very minor and is not expected to result in adverse effects.
The action area is within designated critical habitat which provides migration and/or foraging for all of the species listed in Table 1 above. The action area also contains EFH for Pacific salmon and groundfish which will be explained further in Section 3.

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.

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

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

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

- Evaluate the range-wide 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. Range-wide Status of the Species and Critical Habitat

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

One factor affecting the status of ESA-listed species considered in this opinion, and aquatic habitat at large, is climate change. Climate change is likely to play an increasingly important role in determining the abundance and distribution of ESA-listed species, and the conservation value of designated critical habitats in the Pacific Northwest. These changes will not be spatially homogeneous across the Pacific Northwest. Major ecological realignments are already occurring in response to climate change (IPCC WGII, 2022). Long-term trends in warming have continued at global, national and regional scales. Global surface temperatures in the last decade (2010’s) 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 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; Jacox et al., 2018). Global warming and anthropogenic loss of biodiversity represent profound threats to ecosystem functionality (IPCC WGII, 2022). These two factors are often examined in isolation, but likely have interacting effects on ecosystem function.

Updated projections of climate change are similar to or greater than previous projections (IPCC WGI, 2021). The 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 & 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 have collected hundreds of papers documenting the major themes relevant for salmon (Crozier, 2015, 2016, 2017; Crozier & Siegel, 2018; Siegel & Crozier, 2019, 2020). 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 fires, and insect outbreaks (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). 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 stream-flows) 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 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 et al., 2012; Burke et al., 2013). It is generally accepted that salmon marine survival is size-dependent, and thus larger and faster growing fish are more likely to survive (Gosselin et al., 2021). Furthermore, early arrival timing in the marine environment is generally considered advantageous for populations migrating through the CR. However, the optimal day of arrival varies across years, depending on the seasonal development of productivity in the California Current, which affects prey available to salmon and the risk of predation (Chasco et al., 2021). Siegel and Crozier (2019) point out the concern that for some salmon populations, climate change may drive mismatches between juvenile arrival timing and prey availability in the marine environment. However, phenological diversity can contribute to metapopulation-level resilience by reducing the risk of a complete mismatch. Carr-Harris et al. (2018), explored phenological diversity of marine migration timing in relation to zooplankton prey for sockeye salmon (*O. nerka*) from the Skeena River of Canada. They found that sockeye migrated over 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 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 and Atlantic salmon also have demonstrated synchrony in productivity across a broad latitudinal range (Stachura el al., 2014; Olmos et al., 2020).
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 & 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 & Zabel, 2006; Crozier et al., 2010, 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 MCR than those from the SRB. 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, though the low levels of remaining diversity present challenges to this effort (Anderson et al., 2015; Freshwater, 2019). Salmon historically maintained relatively consistent returns across variation in annual weather through the portfolio effect, in which different populations are sensitive to different climate drivers. Applying this concept to climate change, emphasized the additional need for populations with different physiological tolerances (Anderson et al., 2015; Schindler et al., 2015). Loss of the portfolio increases volatility in fisheries, as well as ecological systems, as demonstrated for Fraser River and Sacramento River stock complexes (Freshwater et al., 2019; Munsch et al., 2022).

2.2.1 Status of the Species

Table 3, below provides a summary of listing and recovery plan information, status summaries and limiting factors for the species addressed in this opinion. More information can be found in recovery plans and status reviews for these species. Acronyms appearing in the table include DPS (Distinct Population Segment), ESU (Evolutionarily Significant Unit), ICTRT (Interior

Columbia Technical Recovery Team), MPG (Multiple Population Grouping), NWFSC (Northwest Fisheries Science Center), TRT (Technical Recovery Team), and VSP (Viable Salmonid Population).

Table 3. Listing classification and date, recovery plan reference, most recent status review, status summary, and limiting factors for each species considered in this opinion.

Species	**Listing Classification and Date**	**Recovery Plan Reference**	**Most Recent Status Review**	**Status Summary**	**Limiting Factors**
LCR Chinook salmon	Threatened 06/28/05	(NMFS, 2013)	(NMFS, 2022a; Ford, 2022)	This ESU comprises 32 independent populations. Relative to baseline VSP levels identified in the recovery plan (Dornbusch & Sihler, 2013), there has been an overall improvement in the status of a number of fall-run populations although most are still far from the recovery plan goals. Spring-run Chinook salmon populations in this ESU are generally unchanged. Most of the populations are at a "high" or "very high" risk due to low abundances and the high proportion of hatchery-origin fish spawning naturally. Many of the populations in this ESU remain at "high risk," with low natural-origin abundance levels. Overall, we conclude that the viability of the LCR Chinook salmon ESU has increased somewhat since 2016, although the ESU remains at "moderate" risk of extinction.	• Reduced access to spawning and rearing habitat. • Hatchery-related effects. • Harvest related effects on fall Chinook salmon. • An altered flow regime and CR plume. • Reduced access to off-channel rearing habitat. • Reduced productivity resulting from sediment and nutrient-related changes in the estuary. • Contaminant
UCR spring-run Chinook salmon	Endangered 06/28/05	(Upper Columbia Salmon Recovery Board, 2007)	(NMFS, 2022b; Ford, 2022)	This ESU comprises four independent populations. Current estimates of natural-origin spawner abundance decreased substantially relative to the levels observed in the prior review for all three extant populations. Productivities also continued to be very low, and both abundance and productivity remained well below the viable thresholds called for in the Upper Columbia Salmon Recovery Plan for all three populations. Based on the information available for this review, the UCR spring-run Chinook salmon ESU remains at high risk, with viability largely unchanged since 2016.	• Effects related to hydropower system in the mainstream Columbia River. • Degraded freshwater habitat. • Degraded estuarine and nearshore marine habitat. • Hatchery-related effects. • Persistence of non-native (exotic) fish species. • Harvest in CR fisheries.

Species	**Listing Classification and Date**	**Recovery Plan Reference**	**Most Recent Status Review**	**Status Summary**	**Limiting Factors**
SR spring/summer-run Chinook salmon	Threatened 06/28/05	(NMFS, 2017a)	(NMFS, 2022c; Ford, 2022)	This ESU comprises 28 extant and four extirpated populations. There have been improvements in abundance/productivity in several populations relative to the time of listing, but the majority of populations experienced sharp declines in abundance in the recent five-year period. Overall, at this time we conclude that the Snake River spring/ summer-run Chinook salmon ESU continues to be at moderate-to-high risk.	• Degraded freshwater habitat. • Effects related to the hydropower system in the mainstem CR. • Altered flows and degraded water quality. • Harvest-related effects. • Predation
SR fall-run Chinook salmon	Threatened 6/28/05	(NMFS, 2017b)	(NMFS, 2022d; Ford, 2022)	This ESU has one extant population. The single extant population in the ESU is currently meeting the criteria for a rating of "viable" developed by the ICTRT, but the ESU as a whole is not meeting the recovery goals described in the recovery plan for the species, which require the single population to be "highly viable with high certainty" and/or will require reintroduction of a viable population above the Hells Canyon Complex (NMFS 2017b). The Snake River fall-run Chinook salmon ESU therefore is considered to be at a moderate-to-low risk of extinction.	• Degraded floodplain connectivity and function. • Harvest-related effects. • Loss of access to historical habitat above Hells Canyon and other SR dams. • Impacts from mainstem Columbia River and SR hydropower systems. • Hatchery-related effects. • Degraded estuarine and nearshore habitat.
UWR Chinook salmon	Threatened 06/28/05	(ODFW & NMFS, 2011)	(NMFS, 2016; Ford, 2022)	This ESU comprises seven populations. Abundance levels for all but Clackamas River DIP remain well below their recovery goals. Overall, there has likely been a declining trend in the viability of the UWR Chinook salmon ESU since the last review. The magnitude of this change is not sufficient to suggest a change in risk category, however, so the UWR Chinook salmon ESU remains at "moderate" risk of extinction.	• Degraded freshwater habitat. • Degraded water quality. • Increased disease incidence. • Altered stream flows. • Reduced access to spawning and rearing habitats. • Altered food web due to reduced inputs of microdetritus. • Predation by native and non-native species, including hatchery fish. • Competition related to introduced salmon and steelhead. • Altered population traits due to fisheries and bycatch.

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
CR chum salmon	Threatened 6/28/05	(NMFS, 2013)	(NMFS, 2022a; Ford, 2022)	This species has 17 populations divided into 3 MPGs. Three populations exceed the recovery goals established in the recovery plan (Dornbusch & Sihler, 2013). The remaining populations have unknown abundances. Abundances for these populations are assumed to be at or near zero. The viability of this ESU is relatively unchanged since the last review (moderate to high risk), and the improvements in some populations do not warrant a change in risk category, especially given the uncertainty regarding climatic effects in the near future.	• Degraded estuarine and nearshore marine habitat. • Degraded freshwater habitat. • Degraded stream flow as a result of hydropower and water supply operations. • Reduced water quality. • Current or potential predation . • An altered flow regime and CR plume. • Reduced access to off-channel rearing habitat in the lower CR. • Reduced productivity resulting from sediment and nutrient-related changes in the estuary. • Juvenile fish wake strandings. • Contaminants
LCR coho salmon	Threatened 6/28/05	(NMFS, 2013)	(NMFS, 2022a; Ford, 2022)	Of the 24 populations that make up this ESU, only six of the 23 populations for which we have data appear to be above their recovery goals. Overall abundance trends for the LCR coho salmon ESU are generally negative. Natural spawner and total abundances have decreased in almost all DIPs, and Coastal and Gorge MPG populations are all at low levels, with significant numbers of hatchery-origin coho salmon on the spawning grounds. Improvements in spatial structure and diversity have been slight, and overshadowed by declines in abundance and productivity. For individual populations, the risk of extinction spans the full range, from “low” to “very high.” Overall, the LCR coho salmon ESU remains at “moderate” risk, and viability is largely unchanged since 2016.	• Degraded estuarine and near-shore marine habitat. • Fish passage barriers. • Degraded freshwater habitat. • Hatchery-related effects. • Harvest-related effects. • An altered flow regime and CR plume. • Reduced access to off-channel rearing habitat in the lower CR. • Reduced productivity resulting from sediment and nutrient-related changes in the estuary. • Juvenile fish wake strandings. • Contaminants

Species	**Listing Classification and Date**	**Recovery Plan Reference**	**Most Recent Status Review**	**Status Summary**	**Limiting Factors**
SR sockeye salmon	Endangered 6/28/05	(NMFS, 2015)	(NMFS, 2022f; Ford, 2022)	This single population ESU is at remains at "extremely high risk," although there has been substantial progress on the first phase of the proposed recovery approach developing a hatchery-based program to amplify and conserve the stock to facilitate reintroductions. Current climate change modeling supports the "extremely high risk" rating with the potential for extirpation in the near future (Crozier et al. 2020). The viability of the SR sockeye salmon ESU therefore has likely declined since the time of the prior review, and the extinction risk category remains "high."	• Effects related to the hydropower system in the mainstem CR. • Reduced water quality and elevated temperatures in the SR. • Water quantity • Predation
UCR steelhead	Threatened 1/05/06	(Upper Columbia Salmon Recovery Board, 2007)	(NMFS, 2022b; Ford, 2022)	This DPS comprises four independent populations. The most recent estimates (five-year geometric mean) of total and natural-origin spawner abundance have declined since the last report, largely erasing gains observed over the past two decades for all four populations (Figure 12, Table 6). Recent declines are persistent and large enough to result in small, but negative 15-year trends in abundance for all four populations. The overall UCR steelhead DPS viability remains largely unchanged from the prior review, and the DPS is at high risk driven by low abundance and productivity relative to viability objectives and diversity concerns.	• Adverse effects related to the mainstem CR hydropower system. • Impaired tributary fish passage. • Degraded floodplain connectivity and function, channel structure and complexity, riparian areas, large woody debris recruitment, stream flow, and water quality. • Hatchery-related effects. • Predation and competition. • Harvest-related effects.

Species	**Listing Classification and Date**	**Recovery Plan Reference**	**Most Recent Status Review**	**Status Summary**	**Limiting Factors**
LCR steelhead	Threatened 1/05/06	(NMFS, 2013)	(NMFS, 2022a; Ford, 2022)	This DPS comprises 23 historical populations, 17 winter-run populations and 6 summer-run populations. 10 are nominally at or above the goals set in the recovery plan (Dornbusch & Sihler, 2013). However, it should be noted that many of these abundance estimates do not distinguish between natural and hatchery-origin spawners. The majority of winter-run steelhead DIPs in this DPS continue to persist at low abundance levels (hundreds of fish), with the exception of the Clackamas and Sandy River DIPs, which have abundances in the low 1,000s. Although the five-year geometric abundance means are near recovery plan goals for many populations, the recent trends are negative. Overall, the LCR steelhead DPS is therefore considered to be at "moderate" risk.	• Degraded estuarine and nearshore marine habitat. • Degraded freshwater habitat. • Reduced access to spawning and rearing habitat. • Avian and marine mammal predation. • Hatchery-related effects. • An altered flow regime and CR plume. • Reduced access to off-channel rearing habitat in the lower CR. • Reduced productivity resulting from sediment and nutrient-related changes in the estuary. • Juvenile fish wake strandings. • Contaminants
UWR steelhead	Threatened 1/05/06	(ODFW & NMFS, 2011)	(NMFS, 2016; Ford, 2022)	This DPS has four demographically independent populations. Populations in this DPS have experienced long-term declines in spawner abundance. Although the recent magnitude of these declines is relatively moderate, continued declines would be a cause for concern. In the absence of substantial changes in accessibility to high-quality habitat, the DPS will remain at "moderate-to-high" risk. Overall, the UWR steelhead DPS is therefore at "moderate-to-high" risk, with a declining viability trend.	• Degraded freshwater habitat. • Degraded water quality. • Increased disease incidence. • Altered stream flows. • Reduced access to spawning and rearing habitats due to impaired passage at dams. • Altered food web due to changes in inputs of microdetritus. • Predation by native and non-native species, including hatchery fish and pinnipeds. • Competition related to introduced salmon and steelhead. • Altered population traits due to interbreeding with hatchery origin fish.
MCR steelhead	Threatened 1/05/06	(NMFS, 2009)	(NMFS, 2022h; Ford, 2022)	This DPS comprises 17 extant populations. Recent (five-year) returns are declining across all populations, the declines are from relatively high returns in the previous five-to-ten year interval, so the longer-term risk metrics that are meant to buffer against short-period changes in abundance and productivity remain unchanged. The MCR steelhead DPS does not currently meet the viability criteria described in the MCR steelhead recovery plan.	• Degraded freshwater habitat. • Mainstem CR hydropower-related impacts. • Degraded estuarine and nearshore marine habitat. • Hatchery-related effects. • Harvest-related effects. • Effects of predation, competition, and disease.

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
SRB steelhead	Threatened 1/05/06	(NMFS, 2017a)	(NMFS 2022i; Ford, 2022)	This DPS comprises 24 populations. Based on the updated viability information available for this review, all five MPGs are not meeting the specific objectives in the draft recovery plan, and the viability of many individual populations remains uncertain. Of particular note, the updated, population-level abundance estimates have made very clear the recent (last five years) sharp declines that are extremely worrisome, were they to continue.	• Adverse effects related to the mainstem CR hydropower system. • Impaired tributary fish passage. • Degraded freshwater habitat. • Increased water temperature. • Harvest-related effects, particularly for B-run steelhead. • Predation • Genetic diversity effects from out-of-population hatchery releases.
Southern DPS of green sturgeon	Threatened 4/07/06	(NMFS, 2018)	(NMFS, 2021)	The Sacramento River contains the only known green sturgeon spawning population in this DPS. The current estimate of spawning adult abundance is between 824 and 1,872 individuals. Telemetry data and genetic analyses suggest that Southern DPS green sturgeon generally occur from Graves Harbor, Alaska to Monterey Bay, California and, within this range, most frequently occur in coastal waters of Washington, Oregon, and Vancouver Island and near San Francisco and Monterey bays. Within the nearshore marine environment, tagging and fisheries data indicate that Northern and Southern DPS green sturgeon prefer marine waters of less than a depth of 110 meters.	• Reduction of its spawning area to a single known population. • Lack of water quantity • Poor water quality • Poaching

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
Southern DPS of eulachon	Threatened 3/18/10	(NMFS, 2017c)	(NMFS, 2022j)	The Southern DPS of eulachon includes all naturally-spawned populations that occur in rivers south of the Nass River in British Columbia to the Mad River in California. Sub populations for this species include the Fraser River, CR, British Columbia and the Klamath River. In the early 1990s, there was an abrupt decline in the abundance of eulachon returning to the CR. Despite a brief period of improved returns in 2001–2003, the returns and associated commercial landings eventually declined to the low levels observed in the mid-1990s. Although eulachon abundance in monitored rivers has generally improved, especially in the 2013–2015 return years, recent poor ocean conditions and the likelihood that these conditions will persist into the near future suggest that population declines may be widespread in the upcoming return years.	• Changes in ocean conditions due to climate change, particularly in the southern portion of the species’ range where ocean warming trends may be the most pronounced and may alter prey, spawning, and rearing success. • Climate-induced change to freshwater habitats. • Bycatch of eulachon in commercial fisheries. • Adverse effects related to dams and water diversions. • Water quality • Shoreline construction • Over harvest • Predation

2.2.2 Status of the Critical Habitat

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

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

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

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

A summary of the status of critical habitats, considered in this opinion, is provided in Table 4, below.

Table 4. Critical habitat, designation date, federal register citation, and status summary for critical habitat considered in this opinion.

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

Species	Designation Date and Federal Register Citation	Critical Habitat Status Summary
CR chum salmon	9/02/05 70 FR 52630	Critical habitat encompasses six sub-basins in Oregon and Washington containing 19 occupied watersheds, as well as the LCR rearing/migration corridor. Most HUC5 watersheds with PCEs for salmon are in fair-to-poor or fair-to-good condition (NMFS, 2005). However, most of these watersheds have some or a high potential for improvement. We rated conservation value of HUC5 watersheds as high for 16 watersheds, and medium for three watersheds.
LCR coho salmon	2/24/16 81 FR 9252	Critical habitat encompasses 10 sub-basins in Oregon and Washington containing 55 occupied watersheds, as well as the LCR and estuary rearing/migration corridor. Most HUC5 watersheds with PCEs for salmon are in fair-to-poor or fair-to-good condition (NMFS, 2005). However, most of these watersheds have some or a high potential for improvement. We rated conservation value of HUC5 watersheds as high for 34 watersheds, medium for 18 watersheds, and low for three watersheds.
SR sockeye salmon	10/25/99 64 FR 57399	Critical habitat consists of river reaches of the Columbia, Snake, and Salmon rivers; Alturas Lake Creek; Valley Creek; and Stanley, Redfish, Yellow Belly, Pettit and Alturas lakes (including their inlet and outlet creeks). Water quality in all five lakes generally is adequate for juvenile sockeye salmon, although zooplankton numbers vary considerably. Some reaches of the Salmon River and tributaries exhibit temporary elevated water temperatures and sediment loads that could restrict sockeye salmon production and survival (NMFS, 2015). Migratory habitat quality in this area has been severely affected by the development and operation of the dams and reservoirs of the Federal Columbia River Power System.
UCR steelhead	9/02/05 70 FR 52630	Critical habitat encompasses 10 sub-basins in Washington containing 31 occupied watersheds, as well as the CR rearing/migration corridor. Most HUC5 watersheds with PCEs for salmon are in fair-to-poor or fair-to-good condition (NMFS, 2005). However, most of these watersheds have some or a high potential for improvement. We rated conservation value of HUC5 watersheds as high for 20 watersheds, medium for eight watersheds, and low for three watersheds.
LCR steelhead	9/02/05 70 FR 52630	Critical habitat encompasses nine sub-basins in Oregon and Washington containing 41 occupied watersheds, as well as the LCR rearing/migration corridor. Most HUC5 watersheds with PCEs for salmon are in fair-to-poor or fair-to-good condition (NMFS, 2005). However, most of these watersheds have some or a high potential for improvement. We rated conservation value of HUC5 watersheds as high for 28 watersheds, medium for 11 watersheds, and low for two watersheds.
UWR steelhead	9/02/05 70 FR 52630	Critical habitat encompasses seven sub-basins in Oregon containing 34 occupied watersheds, as well as the lower Willamette/Columbia River rearing/migration corridor. Most HUC5 watersheds with PCEs for salmon are in fair-to-poor or fair-to-good condition (NMFS, 2005). However, most of these watersheds have some or a high potential for improvement. Watersheds are in good to excellent condition with no potential for improvement only in the upper McKenzie River and its tributaries (NMFS, 2005). We rated conservation value of HUC5 watersheds as high for 25 watersheds, medium for 6 watersheds, and low for 3 watersheds.

Species	**Designation Date and Federal Register Citation**	**Critical Habitat Status Summary**
MCR steelhead	9/02/05 70 FR 52630	Critical habitat encompasses 15 sub-basins in Oregon and Washington containing 111 occupied watersheds, as well as the CR rearing/migration corridor. Most HUC5 watersheds with PCEs for salmon are in fair-to-poor or fair-to-good condition (NMFS, 2005). However, most of these watersheds have some or a high potential for improvement. We rated conservation value of occupied HUC5 watersheds as high for 80 watersheds, medium for 24 watersheds, and low for 9 watersheds.
SRB steelhead	9/02/05 70 FR 52630	Critical habitat encompasses 25 sub-basins in Oregon, Washington, and Idaho. Habitat quality in tributary streams varies from excellent in wilderness and roadless areas, to poor in areas subject to heavy agricultural and urban development (Wissmar et al., 1994). Reduced summer stream flows, impaired water quality, and reduced habitat complexity are common problems. Migratory habitat quality in this area has been severely affected by the development and operation of the dams and reservoirs of the Federal Columbia River Power System.
Southern DPS of green sturgeon	10/09/09 74 FR 52300	Critical habitat has been designated in coastal U.S. marine waters within 60 fathoms depth from Monterey Bay, California (including Monterey Bay), north to Cape Flattery, Washington, including the Strait of Juan de Fuca, Washington, to its United States boundary; the Sacramento River, lower Feather River, and lower Yuba River in California; the Sacramento–San Joaquin Delta and Suisun, San Pablo, and San Francisco bays in California; tidally influenced areas of the CR estuary from the mouth upstream to river mile 46; and certain coastal bays and estuaries in California (Humboldt Bay), Oregon (Coos Bay, Winchester Bay, Yaquina Bay, and Nehalem Bay), and Washington (Willapa Bay and Grays Harbor), including, but not limited to, areas upstream to the head of tide in various streams that drain into the bays. Several activities threaten the PBFs in coastal bays and estuaries and need special management considerations or protection. The application of pesticides, activities that disturb bottom substrates/ adversely affect prey resources/ degrade water quality through re-suspension of contaminated sediments, commercial shipping and activities that discharge contaminants and result in bioaccumulation of contaminants in green sturgeon; disposal of dredged materials that bury prey resources; and bottom trawl fisheries that disturb the bottom/prey resources for green sturgeon.
Southern DPS of eulachon	10/20/11 76 FR 65324	Critical habitat for eulachon includes portions of 16 rivers and streams in California, Oregon, and Washington. All of these areas are designated as migration and spawning habitat for this species. In Oregon, we designated 24.2 miles of the lower Umpqua River, 12.4 miles of the lower Sandy River, and 0.2 miles of Tenmile Creek. We also designated the mainstem CR from the mouth to the base of Bonneville Dam, a distance of 143.2 miles. Dams and water diversions are moderate threats to eulachon in the Columbia and Klamath rivers where hydropower generation and flood control are major activities. Degraded water quality is common in some areas occupied by southern DPS eulachon. In the Columbia and Klamath river basins, large-scale impoundment of water has increased winter water temperatures, potentially altering the water temperature during eulachon spawning periods. Numerous chemical contaminants are also present in spawning rivers, but the exact effect these compounds have on spawning and egg development is unknown. Dredging is a low to moderate threat to eulachon in the CR. Dredging during eulachon spawning would be particularly detrimental.

2.3. Environmental Baseline

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

The action area is located along the southern shoreline of the CR at river mile 15.6 (Campbell, 2022). This is a highly developed area of the Astoria waterfront, and is considered a high energy area of the river with strong lateral currents. The riverbanks at this location are armored with riprap and concrete, and contain minimal riparian vegetation. The substrates within and around the EMB consist primarily of silt and sand (Campbell, 2022). The marina is also relatively isolated from the flowing channel given that it is bound by riprap shorelines and concrete and rock breakwaters that provide protected access for vessels. River flows on the LCR are relatively consistent as a result of the hydrological regulation at upstream dams, but are still subject to twice-daily fluctuations.

Fish habitat in the action area has been adversely affected by a variety of in-water and upland human activities. These activities include: habitat losses from all causes (urbanization, roads, diking, etc.), flood control, irrigation dams, pollution, municipal and industrial water use, introduced species, hatchery production, and climate change as described in section 2.2 above (Dornbusch & Sihler, 2013). The action area is affected by many upriver activities and uses in CR basin watersheds. In general, those conditions have declined in the last 150 years, together influencing conditions in the action area. These multiple watersheds, like the action area, are characterized by loss of connectivity with floodplains and feeding and resting habitat for juvenile salmonids in the form of low-velocity marshland and tidal channel habitats (Bottom et al., 2005). Each of the upland conditions influence habitat characteristics in the action area such as water quality, amount and composition of prey base. Water quality throughout the action area is degraded by urban, industrial, and agricultural practices across the basin that contributes multiple pollutants at levels above natural conditions. Habitat degradation has generally reduced the quality, complexity, and amount of this important rearing and migration habitat for salmon and steelhead. Survival through this reach has declined for both juvenile and adult salmonids resulting in reduced population productivity and abundance.

In addition, the environmental baseline includes the impacts from deep-water dredging to maintain the Federal navigation channel for large commercial vessel traffic and shallow water dredging to maintain marinas for recreational vessels. Therefore, dredging activities occur across numerous areas and microhabitats within the LCR including sloughs, secondary channels, and floodplain wetlands. All of these habitat areas provide rearing space for ESA-listed fish , and all have been dredged by shore-based development and construction maintenance of boat moorage facilities. Floodplain and off-channel sloughs have been cut off by dikes and flood control levees, limiting potential refuge areas and forage sites for juvenile salmonids. The dredge sediment disposal in the LCR has had adverse effects, including displacement of seasonally-flooded wetlands, regular disruption of shallow water benthic prey communities, and most significantly, the creation of attractive nesting habitat for avian predators feeding on juvenile salmonids (Evans et al., 2012; Sebring et al., 2013).

The hydrology and hydrograph of the CR is significantly altered from historical conditions, shifting natural cues that salmonids rely on for spawning and outmigration behavior. River flow is less dynamic, sediment transport has decreased by as much as 50 percent (Sherwood et al., 1990; Simenstad et al., 1992). Other actions such as the depredation and relocation of large colonial nesting waterfowl colonies have reduced the numbers of avian predators that prey upon salmonids in the CR estuary that may improve progress in reaching recovery goals by up to 6 percent (NMFS, 2011). Degraded water quality in the action area results from increased fine sediments, elevated water temperatures (especially during the winter), and a host of municipal and industrial discharges (permitted or otherwise) (LCREP, 2007; Weitkamp, 1994). These conditions are a result of upstream land usage and operations within the Port, all of which influence the LCR estuary and its recovery potential (Fresh et al., 2005).

All ESA-listed Columbia basin salmon and steelhead, in addition to eulachon and green sturgeon may rear and/or migrate through the action area, resulting in effects to individuals, and rearing and migration critical habitat PBFs. Rearing of juvenile salmonids and green sturgeon is likely to occur within the EMB. The marina is relatively isolated from the flowing channel of the CR as stated previously. Upstream migration of adult salmonids and eulachon are likely to occur within the mainstem LCR in proximity to the dredge disposal site, along with downstream migrations of salmonid smolts. Thus, dredging of the EMB would affect rearing fish and dredging disposal would affect migrating fish. Adult salmonids (depending on the species and age of the fish) may spend hours to months within the action area. Juvenile salmonid foraging primarily occurs in waters less than 25 feet deep, which is a large proportion of the action area. Deeper waters and greater flows found in the CR flow land disposal sites would provide a migration corridor.

The baseline also includes the effects of projects that have proceeded subsequent to Section 7 consultation. During the last five years, NMFS has engaged in various Section 7 consultations on Federal projects adversely affecting ESA-listed fish and their habitats in and near the action area. These include vicinity (Clatsop County, Oregon; Pacific County, Washington) to the action area (WCR-2019-11648, WCR-2018-10138, WCR-2017-7450, WCR-2017-6622, WCR-2016-5516), including the effects of actions addressed in programmatic consultations (the SLOPES IV programmatic consultation; NMFS number WCR-2011-05585). In general, those actions caused temporary, construction-related effects (increased noise and turbidity), and longer term effects like increasing overwater coverage. Longer term effects that remain part of the baseline now include hindering quality of downstream migration and reduced benthic production of forage items.

All actions processed under the SLOPES IV programmatic consultation also include minimization measures to reduce or avoid both short-term and long-term effects in the environment. These include requiring grated and translucent materials to allow light penetration, pile caps to prevent piscivorous bird perching, and limits on square footage of new overwater coverage. While some adverse effects of actions implemented under SLOPES IV can reduce fitness and survival in a small number of individuals, the minimization measures reduce the overall contribution to habitat degradation at large. The overall effects of these actions do contribute to the present environmental baseline and the effects of existing structures (e.g. increased shading, reduction in prey, increased predation, and possible minor migration delays) are considered in this consultation.

Despite degraded habitat conditions ESA-listed species migrate through and rear in the action area. Numerous early life history strategies of CR salmonids have been lost as a result of past management actions discussed under the environmental baseline (Bottom et al., 2005). Salmonids in the action area would generally exhibit either a stream-maturing or ocean-maturing life history type. A stream-type life history is exemplified by juvenile salmon and steelhead that typically rear in upstream tributary habitats for over a year. Salmonids exhibiting this life history include: LCR spring-run Chinook salmon, LCR steelhead, LCR coho salmon, MCR steelhead, UWR steelhead, UWR Chinook salmon, SR spring/summer-run Chinook salmon, UCR Chinook salmon, SR steelhead, SR sockeye salmon, and UCR steelhead. These juvenile fish would migrate through the action area as smolts, (approximately 100 to 200 mm in size) swim downstream, and pass by the action area within one or two days (Dawley et al., 1986). An ocean-type life history is exemplified by juvenile salmon that move out of spawning streams and migrate towards the LCR estuary as sub-yearlings and are actively rearing within the LCR estuary. Fish that exhibit these life histories include LCR fall-run Chinook salmon, CR chum salmon, and SR fall-run Chinook salmon. These fish are generally smaller in size (less than 100 mm) and more likely to spend days to weeks residing in tidal freshwater habitats characterized by the action area, with peak abundances occurring March through May (Hering et al., 2010; McNatt et al., 2016).

In addition to variations in outmigration timing, juvenile ESA-listed species also have a wide horizontal and vertical distribution in the CR related to size and life history stage. Generally speaking, juvenile salmonids would occupy the action area across the width of the river, and to average depths of up to 35 feet (Carter et al., 2009). Smaller-sized fish use the shallow inshore habitats and larger fish would use the channel margins and main channel. The pattern of use generally shifts between day and night. Juvenile salmon occupy different locations within the CR, and are typically in shallower water during the day, avoiding predation by larger fish that are more likely to be in deeper water. These juveniles would venture into the deeper areas of the river away from the shoreline, towards the navigation channel and along the bathymetric break (channel margin) and would be closer to the bottom of the channel (Carter et al., 2009). The smaller sub-yearling salmonids would likely congregate along the nearshore areas in shallow water and extend into the channel margins (Bottom et al., 2011). Yet, as Carlson et al. (2001) indicated, there is higher use of the channel margins than previously thought. Considering the parameters above, the relative position of juveniles in the water column suggests higher potential sub-yearling use in areas of 20 to 30 feet deep.

Pacific eulachon are tributary spawners within the LCR, and utilize the mainstem CR for drifting eggs and larvae to the estuary, and for adult migration. Migration of adults into the CR and its tributaries occurs from December through May, with peak abundances and spawning during

February and March over sandy substrates in LCR tributaries. Eggs and larvae are present from February until early June, as they drift in currents downstream to the CR estuary.

Green sturgeon utilize the action area during the summer and early fall months and may be present within the action area early in the IWWW (November) (Moser & Lindley, 2007; Moser et al., 2016). Commercial catches of green sturgeon peak in October in the CR estuary, and records from other estuarine fisheries (Willapa Bay & Grays Harbor, Washington) support the conclusion that sturgeon are present in these estuaries from June until October (Moser & Lindley, 2007).

2.4. Effects of the Action

Under the ESA, "effects of the action" are all consequences to listed species or critical habitat that are caused by the proposed action, including the consequences of other activities that are caused by the proposed action (see 50 CFR 402.02). A consequence is caused by the proposed action if it would not occur but for the proposed action and it is reasonably certain to occur. Effects of the action may occur later in time and may include consequences occurring outside the immediate area involved in the action (see 50 CFR 402.17). In our analysis, which describes the effects of the proposed action, we considered the factors set forth in 50 CFR 402.17(a) and (b).

Effects of the proposed action are reasonably certain to include: 1) annual, temporary, localized reductions in water quality; 2) annual, temporary, localized reductions in available prey; and 3) annual, temporary, localized obstructions to safe passage. These changes in the environment would affect PBFs of critical habitat, and the species that are preset when these effects occur.

2.4.1 Effects on Critical Habitat

The proposed action would affect designated critical habitat for: LCR Chinook salmon, UCR spring-run Chinook salmon, SR spring/summer-run Chinook salmon, UWR spring-run Chinook salmon, SR fall-run Chinook salmon, CR chum salmon, LCR coho salmon, SR sockeye salmon, LCR steelhead, MCR steelhead, UCR steelhead, SR steelhead, UWR steelhead, green sturgeon, and Pacific eulachon. Given the location of the proposed action and life history expression, all of the species considered in these opinions use this area for migration and rearing. The magnitude of these effects would vary spatially and by, species, and life stage, and are discussed below.

Salmonid Critical Habitat

The action area includes the PBFs for freshwater juvenile habitat and migration corridors for all salmonids considered in this opinion. The essential elements of freshwater juvenile rearing habitat are: substrate; optimum water quantity and floodplain connectivity (to form and maintain physical habitat conditions and support juvenile growth and mobility); optimum water quality and forage (that support juvenile development); and natural cover (such as shade, submerged and overhanging large wood, logjams, beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks).

The essential features of freshwater migration corridors are: freedom of obstruction and excessive predation with optimum water quantity and quality conditions; and natural cover (such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels, and undercut banks — which support foraging, mobility and survival).

These essential features are provided by critical habitat within the action area. The essential features in the action area affected by the proposed action would include: *water quality, substrate, forage, and a corridor free of obstruction and predation.*

Water Quality and Migration: The proposed action would have temporary effects on migration corridors and water quality (due to turbidity) within the CR. It would temporarily obstruct or decrease safe passage, in a small area immediately around the suction dredge, 100 feet around and 300 feet downstream from the disposal pipeline during the November 1 to February 28 IWWW. Passage conditions would be made less safe for juveniles by elevated turbidity, and risk of entrainment. The majority of turbidity produced by the suction dredge is expected to remain localized within the 23.3 acre EMB, and in proximity to the active suction dredge due to the EMB being isolated from mainstem flows. The predominant sediments on the river bottom being suspended by the dredge and disposal pipeline are gravel and sand. Due to the coarseness of the sediment, they are expected to settle rapidly (within minutes), and in close proximity (several feet) to their source location. Any finer sediments (silt and clay) that happen to be suspended by the suction dredge and disposal pipeline would settle slower (within an hour). Although the sediments responsible for increased turbidity produced by the suction dredge and disposal pipeline are expected to settle quickly, dredging is proposed to occur daily for four months. Due to the EMB's relative isolation from the mainstem CR, turbidity generated by the suction dredge isn't expected to enter the mainstem CR. Sediment is only expected to enter the mainstem CR during the ebb tide in the upper half of the water column. This would promote the dispersal of sediment and prevent mounding.

Substrate and Forage. Dredging and disposal each modify the substrate where the dredging and disposal occur. These modifications are not expected to modify rearing or migration values within EMB, with the exception of the corollary impact on benthic forage. The proposed action would temporarily reduce prey availability in a limited area within the. However, available forage from littoral sources in the immediate area outside of the EMB would remain plentiful. Epibenthic invertebrates also provide food for these juvenile salmonids (McCabe et al., 1998). The aquatic invertebrates occupy the upper surface of the river bottom with a life cycle of many weeks to months before emerging into the water column. The proposed dredging operation would disturb benthic habitat and reduce benthic productivity. The level and nature of the disturbance is not unlike natural processes in the CR that continually move river bottom sediments, burying or eroding benthic habitat. Recolonization of the benthic habitat by invertebrates is generally rapid (within weeks to months), but is dependent upon the frequency of the dredging disturbance and the availability of upstream communities to recolonize the affected area (McCabe et al., 1998). Loss of forage would last longer where the frequency and duration of the dredging delays natural recolonization.

We do not expect that dredge disposal will cause reduced prey availability for juvenile salmonids. The sediment disposal sites are outside the littoral area, where juvenile salmonids typically occur. Also, the community of benthic invertebrates in the action area are more evolved to handle natural disturbance regimes of faster flows and dynamic coarse grain sediment redistribution. Juvenile salmonids are likely not rearing in these locations due to a lack of habitat complexity (no wood or current breaks). Adult salmonids do not forage when in freshwater.

Eulachon Critical Habitat

The action area includes eulachon PBFs for migration corridors, spawning and egg/larval development.

The proposed action would not have any permanent effects to adult eulachon migration corridors within the CR, but would temporarily obstruct or decrease safe passage of adult eulachon. Only a small area immediately around the suction dredge, 100 feet around, and 300 feet downstream of the disposal pipeline would be affected during the November 1 to February 28 IWWW due to elevated turbidity. There is also a risk of entertainment of eggs/larvae, as described below in Section 2.4.2 (Effects on Listed Species). Additionally, the proposed action would not alter spawning substrate that eulachon rely on because adult eulachon don't spawn in this section of the LCR as they typically favor large tributaries to the CR (i.e., Sandy River, Washougal River).

Green Sturgeon Critical Habitat

The action area includes the PBFs of estuary migratory corridors and prey base for green sturgeon. The proposed action would affect the elements of green sturgeon critical habitat, similar to those described above for juvenile salmonids (e.g., water quality, substrate, forage, and obstruction & predation-free corridors). The disturbance of both estuary migratory corridors and prey base are both temporary and these conditions are not a major threat to the critical habitat of the southern DPS of green sturgeon (NMFS, 2018). Effects on the features of critical habitat, similar to those presented above, while adverse, are temporary and are expected to have ameliorated by the time green sturgeon have returned to rely on this portion of the designated area, with no impairment of conservation value.

2.4.2 Effects on Listed Species

Effects of the action on species is based on individual fish exposure to the habitat changes describes above, or effects occurring to the fish themselves. In this case, fifteen ESA-listed fish species of the upper and lower Columbia basins occupy the action area and they would be exposed to the habitat effects of the action, as well as direct exposure to the dredging equipment.

The potential effects anticipated to ESA-listed fish species exposed in the action area are associated with the habitat effects described below. These include: *short-term alterations in water quality from the action, short-term changes in benthic forage, and temporary obstruction of safe passage due to the risk of entrainment of fish by the dredge equipment*. The level of exposure varies by timing and location of activity when different densities and life history stages of the ESA-listed fish would be present. The magnitude of exposure experienced by ESA-listed species is directly related to the amount of time the dredge is actively removing material from the benthos, as approximated by days of operation per year. In this case, dredging would occur for up to 120 days per year over 5 years.

Exposure of adult and juvenile fish would increase with greater duration and frequency of dredging. The greatest exposure for juvenile salmonids and green sturgeon to water quality, forage, and entrainment effects would occur during dredging activities with the EMB in-water depths typically less than -25 feet where sub-yearling salmonids (fall Chinook, and LCR chum salmon) and juvenile green sturgeon tend to rear and forage. Adult salmonids, and eulachon, as well as smolting, stream-type salmonids (spring-run Chinook salmon, coho salmon, sockeye salmon and steelhead) would have the greatest risk of exposure to short-term water quality alterations while migrating through the dredge disposal sites. These fish would likely not be exposed to the dredging effects described for rearing fish above as the Port's EMB is mostly isolated from the mainstem CR. This would likely preclude most adult salmonids from entering the area where majority of dredging would occur.

Salmonid Exposure and Effects

Adult salmonids. Though peak migratory periods vary by species, some adult CR salmonids are reasonably certain to be present in the action area during the IWWW, and would be exposed to the effects of the action. Adult Chinook salmon presence in the action area is most likely from late spring through the fall. Adult coho salmon presence is most likely in late summer through early winter. Adult chum salmon primarily occur during the fall. Adult sockeye salmon presence would most likely range from late spring to late summer. Adult steelhead presence would most likely range from early summer to early fall (from passage data at Bonneville Dam 10-year average, http://www.cbr.washington.edu/dart/adult_hrt.html). Based on the broad run timing of these species, and the proposed work period of November 1 to February 28, exposure is extremely unlikely for adult SR sockeye salmon. All other CR species of adult salmonids are likely to have at least some exposure to the effects of the proposed action, but peak times of presence for most adults do not correspond fully with the IWWW.

Exposure and Response to Dredging Equipment Operation (Safe Passage/Entrainment): Some adult Chinook salmon, coho salmon, chum salmon, and steelhead are likely to be present in the action area during the proposed action. However, only a few adult fish would experience adverse effects from the proposed action due to:

- The limited footprint of the dredging disposal pipeline relative to the size of the CR estuary (limiting probability of exposure to individual fish);
- The isolation of the dredging sites within the enclosed EMB from the mainstem CR;
- The intermittent nature of the action; and
- The migratory and avoidance behaviors inherent to adult salmon and steelhead, including strong homing instinct and swimming speed which are expected to limit their exposures.

Exposure to the habitat disruptions and the suction dredge are likely to be limited because of the size of the migration corridor in this area, and the fact that adult salmonids are not shallow water obligate. The LCR estuary is a massive body of water that presents no current migratory obstacles beyond high water temperatures that can occur during late summer. As a result of this, migrating adult salmon are typically widely dispersed in the estuary. The action area is less than one percent of the total area of the CR estuary, with sufficient space (3.5 miles) to the north of the dredging disposal location for adult fish to safely pass. Further, the Port's narrow access channel would prevent most adult fish from entering the EMB dredge area. In the event these adult salmonids enter the EMB, they are likely to easily avoid the dredge operation due to their strong swimming ability. Adult salmonids are able to avoid the suction dredge intake with no likelihood of entertainment. These conditions, coupled with the adult run-timing previously discussed, result with few adult salmon (of any species) being exposed to dredging equipment operations. Operation of equipment used for disposal of the dredged material has minimal risk to adult salmonids due to their strong swimming ability. This ability allows for avoidance of entrainment and turbidity plumes (see below) generated by the dredging operation during their upstream migrations. We anticipate adult salmonids would pass through the action area without experiencing adverse effects.

Exposure and Response to Turbid Conditions (Water Quality Reduction): We suspect adult ESA-listed salmonids that do encounter turbidity associated with dredge/disposal operations to travel rapidly upstream, limiting their exposure. This is due to the fact that the rate of migration of adult salmonids range between 1.0–2.6 km/h (Quinn, 1988). Studies show that salmonids are able to detect and distinguish turbidity and other water quality gradients, and larger salmonids are more tolerant to suspended sediment than smaller juveniles (Bisson & Bilby, 1982; Servizi & Martens, 1991; 1992). As salmonids grow and their swimming ability increases, their dependence on shallow nearshore habitat declines rapidly (Groot & Margolis, 1991). Adult salmonids would typically be in the main river channel at depths of 10 to 20 feet below the water surface and off the bottom (Johnson et al., 2005). Larger adult salmon readily respond by avoiding waters affected by suspended sediment to find refuge and/or passage conditions within unaffected adjacent areas. Thus, to the extent that any adults are exposed to turbidity generated by projected activities, they are expected to respond by avoiding excessively turbid conditions and find passage within unaffected adjacent areas. Specifically, we do not expect these fish to move into the confined EMB space where dredging would occur. These fish may experience some turbidity near the entrance of the EMB or within 300 feet of the sediment discharge pipe located within the mainstem CR where sediments are actively settling out. In both cases, we anticipate adult salmonids would pass through the action area without experiencing adverse effects due to the brevity of exposure.

Juvenile salmonids. Dredging around the Port’s dock in fall through mid-winter would occur when juvenile salmonids are present, but at very low density, and at depths ranging from approximately -18 to -45 feet MLLW. These depths are deeper than their preferred rearing and migratory habitats. Removal of dredged material would temporarily and minimally alter the river bed. However, it would be within the normal range of seasonal changes to the river bed from typical bed load transport. The level of exposure juvenile salmonids would have to the effects of the action would vary and depend on species and life history, along with the location, timing, and depth of the activities. Among those exposed, specific species would be more vulnerable due to their age/size when they are experiencing the effects of the action.

Juvenile ESA-listed species migrate in the vicinity of and may rear in the action area at different time periods. Juvenile salmonids are present in the action area year round, peaking during one or two periods from late winter (March) through summer. They have a lesser presence in the fall and early winter. Juvenile Chinook salmon and sockeye salmon are present year round; primarily from spring to early fall, although the presence of sub-yearlings extends later into the fall.

Juvenile chum salmon are present from winter to spring. Juvenile coho salmon and steelhead are present year-round with a primary timing range of spring to mid-summer.

Juvenile ESA-listed species migrate through the action area at different rates depending on species and life history. Numerous early life history strategies of the CR salmonids have been lost as a result of past management actions discussed under the environmental baseline (Bottom et al., 2005). Today, salmonids expected in the action area would generally exhibit either a stream-maturing or ocean-maturing life history type. Stream type juvenile salmon and steelhead typically rear in upstream tributary habitats for over a year. These include: LCR spring-run Chinook salmon, LCR steelhead, LCR coho salmon, MCR steelhead, UWR steelhead, UWR spring-run Chinook salmon, SR spring/summer-run Chinook salmon, UCR Chinook salmon, SR steelhead, SR sockeye, and UCR steelhead. These fish would migrate through the action area as smolts. These juveniles tend to move quickly downstream, are 100–200 mm in size, and would move through the action area within 1–2 days. Ocean-type juvenile salmon tend to move out of spawning streams and migrate towards the LCR estuary as sub-yearlings and are actively rearing within the LCR. These include: LCR fall-run Chinook salmon, CR chum salmon, and SR fall-run Chinook salmon. These fish are smaller in size (less than 100 mm) and are more likely to spend days to weeks in the action area foraging (Carter et al., 2009).

Juvenile ESA-listed salmonids have a wide horizontal and vertical distribution related to size and life history stage. Generally speaking, juvenile salmonids would occupy the action area as well as across the width of the river and to average depths of up to 35 feet (Carter et al., 2009). Smaller-sized fish use the shallow nearshore and shoreline habitats, while larger fish use the channel margins and main channel. The pattern of use generally shifts between day and night. Juvenile salmon occupy different locations within the CR. They are typically present in shallower water during the day in order to avoid predation by larger fish that are more likely to be in deeper water. These juveniles would sometimes venture into the deeper areas of the river away from the shoreline, moving towards the navigation channel and along the bathymetric break/channel margin, moving closer to the bottom of the channel. Carlson et al. (2001) notes there is a higher percentage of use along the channel margins than either the shallow nearshore or channel, which indicates potential underestimates for nearshore sub-yearlings. The juvenile’s position in open water tends to be about 3 meters below the surface (Carter et al., 2009). They are a minimum of 2 meters off of the bottom in shallow areas, and 3 to 10 meters off the bottom on the channel margins. They’re also 5 to 15 meters off the bottom in the main channel with sub-yearlings being closer to the bottom than older (1+ year) fish (Carlson et al., 2001; Carter et al., 2009). The smaller sub-yearling salmonids would likely congregate along the nearshore areas in shallow water and extend into the channel margins (Bottom et al., 2011). Yet, as Carlson et al. (2001) indicated, there is a higher use of the channel margins than previously thought. Considering the parameters above, the relative juvenile position in the water column suggests higher potential sub-yearling use in areas of -20 to -30 feet.

Exposure and Response to Equipment Operation (*Safe Passage/Entrainment*): Sub-yearling salmonids in the action area are more likely to be displaced and entrained by dredging equipment due to their size (<100mm), and inferior swimming ability. These sub-yearlings include LCR Chinook salmon, CR chum salmon, and (to a limited extent) SR fall-run Chinook salmon. The IWWW for dredging has been established when the density of sub-yearlings would be lowest, thus limiting exposure probability. At low densities (number of fish per unit area), the probability of a sub-yearling occupying the same area in which the suction dredge is operating is extremely low. This is due to the suction dredge being highly localized to the area in which the suction head is operating (<1 cubic meter). However, any sub-yearlings in the vicinity of the suction head or within 1 meter above it, has an increased risk of entrainment, exposure to turbid conditions, injury, and death. In the shallower waters, sub-yearlings are closer to the bottom and are less able to escape entrainment flows. Larger juvenile smolts (>100mm) actively migrating within the mainstem CR are (like adult salmonids) not likely to enter the enclosed EMB during their migration. However, in the event that a smolt does enter the EMB, their increased swimming abilities allow for a similar avoidance response to adults. This would further minimize but not completely eliminate the risk of entrainment and subsequent injury or death of these fish.

Exposure and Response to Turbid Conditions (Water Quality Reduction): The effects of suspended sediment and turbidity on fish range from beneficial to detrimental. Elevated total suspended solids (TSS) have been reported to enhance cover conditions, reduce piscivorous fish/bird predation rates, and improve survival (Newcombe & Jensen, 1996). Although, elevated TSS have also been reported to cause physiological stress, reduce growth, and adversely affect survival. Fish may experience a reduction in predation from piscivorous fish and birds by occupying turbid waters (Gregory & Levings, 1998). However, chronic exposure to these conditions can cause physiological stress responses that can increase maintenance energy needs and reduce feeding and growth (Lloyd et al., 1987; Redding et al., 1987; Servizi & Martens, 1991). Juvenile salmonids tend to avoid streams that are chronically turbid, such as glacial streams or those disturbed by human activities (Lloyd et al., 1987). The fish may forgo avoidance if the streams are along migration routes. Depending on the concentrations of suspended solids and the food supply, juvenile fish would either seek refuge in adjacent areas with less turbidity. They may also remain in the area and take advantage of the additional cover provided by the turbid water. Death or injury to ESA-listed salmonids directly from an increase in turbidity within the EMB and the disposal pipeline is not likely. Only a few ESA-listed fish in the action area are likely to experience any of the beneficial or adverse effects caused by suspended solids as described above. This is due to the small area of river affected and the low densities of juvenile salmonids likely to be present and exposed to elevated turbidity.

Exposure and Response to Reduced Benthic Prey: Sub-yearling salmonids in the action area are also likely to be exposed to a slight reduction in forage, described below in the effects on Critical Habitat. Sub-yearlings are actively feeding as they move downstream. Salmonids are opportunistic predators and feed on a variety of marine invertebrates, specifically epibenthic invertebrates (Meehan, 1991). Loss of forage would occur where frequency and duration of the dredging delays natural recolonization. Dredging operations would disturb benthic habitat and reduce benthic productivity temporarily. Because disturbance to the benthos would be localized and infrequent, recolonization of the benthic habitat is relatively rapid (within weeks to months) (McCabe et al., 1998). Prey availability in nearby undisturbed sites would remain unaffected. We expect fish to not have noticeably diminished growth or fitness. The limited and localized loss of prey is not likely to reduce available forage for rearing salmonids to a significant degree to have an impact on juvenile fish survival. However, the juvenile salmonids in the CR estuary primarily feed visually on small invertebrates (i.e., Dipterans, Psychosidadae, and Corophium), so their ability to effectively feed will decline with elevated turbidity (Roegner et al., 2004). This would likely reduce growth, lipid stores, and ultimately fitness and survival in a small number of sub-yearling juvenile fish, which are more likely to be rearing within the EMB.

Summary of Salmonid Response to Effects

When adults and juveniles are considered together, it is likely that some individual fish would encounter the dredge within their migration corridor. Of these individual fish, most adults are not expected to alter their pathway or delay their rate of migration. Adult fish are intent on moving upstream and a small deviation from the migration path would not significantly change overall distribution or risk of predation. Migrating juvenile salmonids however would largely avoid the dredging and can move in and out of the turbidity plume. This level of avoidance would be minor and within the normal migration patterns, and thus not likely to increase the risk of predation or otherwise harm these fish except if the juveniles enter deeper water to avoid turbid conditions, where they are likely to encounter larger fish that could increase predation upon a small number of individuals.

Adult salmonids would easily escape entrainment flows. However, sub-yearling salmonids are less able to escape entrainment, and are subject to a wider zone of potential entrainment due to lower swimming stamina and speed. Dredging on channel margins and shallows where sub-yearling salmonids congregate is likely to entrain sub-yearlings. The zone of potential entertainment extends one meter from the suction dredge. A few sub-yearling salmonids (LCR fall-run Chinook salmon, SR fall-run Chinook salmon, and CR chum salmon) are reasonably certain to be injured or killed over for the 5-year duration of the permit. We cannot quantify the number of sub-yearling salmonids that would be killed from entrainment. We do expect the numbers to be low, based on BMPs that restrict the suction dredge being operated within the water column. The number of sub-yearling salmonids killed or injured by entrainment is not expected to reduce the population abundance in a manner that is detectable among returning adults of these populations.

The action would be repetitive annually and occur in shallow water preferred by juvenile salmonids; operation would occur up to 120 days per year. As such, we expect the forage base to be slightly diminished within the action area relative to unaffected adjacent shallow-water habitats. Salmonid foraging in the action area occurs exclusively among juveniles, and we expect that during the weeks to months that the action area re-establishes its prey communities, the availability of alternative feeding areas and upstream food sources are expected to provide adequate prey availability that few fish would experience competition for prey, reduced growth, or diminished fitness. As a result, only a very low number of each cohort of juvenile listed salmonids present during and for several weeks after the action occurs would be adversely affected.

Eulachon Exposure and Effects

Eulachon. Adult eulachon may be exposed to the effects of the dredging during their annual winter spawning migration through the action area. However, the peak of their migration occurs during the latter portion of the IWWW and after (February–March). Migrating adult eulachon would respond similarly to the turbidity as adult salmonids. Very few individual fish would encounter the dredge within their migration corridor, and most would not alter their pathway or delay their rate of migration. The vast majority of eulachon spawning takes place in Washington State tributaries, including the Cowlitz, Elochoman, Kalama, and other watersheds. Spawning takes place atop sand and fine gravel substrates to which the eggs adhere and mature. These eggs often are transported downstream throughout this maturation process by sediment transport processes that occur along the riverine corridor. Once eggs are hatched, typically after about 30 days, the larvae disperse throughout the water column and are widely distributed as they drift downstream passively. The proposed work window for this project ends in late February, prior to the peak of eulachon larval outmigration which occurs from April through June. Thus, outmigration timing, along with the partially enclosed EMB, significantly reduces the potential of eulachon eggs and larvae being present during the dredging and disposal activities.

2.5. Cumulative Effects

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

Some continuing non-Federal activities are reasonably certain to contribute to climate effects within the action area. However, it is difficult if not impossible to distinguish between the action area’s future environmental conditions caused by global climate change that are properly part of the environmental baseline *vs.* cumulative effects. Therefore, all relevant future climate-related environmental conditions in the action area are described earlier in the discussion of environmental baseline (Section 2.3).

For this action, state or private activities in the vicinity of the project location are expected to cause cumulative effects in the action area. Additionally, future state and private activities in upstream areas are expected to cause habitat and water quality changes that are expressed as cumulative effects in the action area. Our analysis considers how future activities in the CR basin are likely to influence habitat conditions in the action area; and cumulative effects caused by specific future activities in the vicinity of the project location.

Approximately 6 million people live in the CR basin, concentrated largely in urban centers. The effect of that population is expressed as changes to physical habitat and loadings of pollutants contributed to the CR. These changes were caused by: residential, commercial, industrial, agricultural, and other land uses for economic development, and are described in the Environmental Baseline (Section 2.3). The collective effects of these activities tend to be expressed most strongly in lower river systems. Here, the impacts of numerous upstream land management actions aggregate to influence natural habitat processes and water quality. As such, these effects accrue within this action area, though most are generated from actions upstream of the action area. As the human population grows, the range of effects described here are likely to intensify.

Additional changes include: basin-wide loss or degradation of stream channel morphology, spawning substrates, instream roughness and cover, estuarine rearing habitats, wetlands, floodplains, riparian areas, water quality (e.g., temperature, sediment, dissolved oxygen, contaminants), fish passage, and habitat refugia. Those changes reduced the ability of populations of ESA-listed species to sustain themselves in the natural environment by altering or interfering with their behavior in ways that reduce their survival throughout their life cycle. The environmental changes also reduced the quality and function of critical habitat PBFs that are necessary for successful spawning, production of offspring, and migratory access. Migratory access is necessary for adult fish to swim upstream to reach spawning areas and for juvenile fish to proceed downstream and reach the ocean. Without those features, the species cannot successfully spawn and produce offspring.

Widespread degradation of aquatic habitat associated with intense natural resource extraction is no longer as common as they used to be. However, ongoing and future land management actions are likely to continue to have a depressive effect on aquatic habitat quality in the CR basin and within the action area. As a result, recovery of aquatic habitat is likely to be slow in most areas. Also, cumulative effects from basin-wide activities are likely to have a slightly negative impact on population abundance trends and the quality of critical habitat PBFs into the future.

2.6. 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.

2.6.1 ESA Listed Species

Most of the component populations of LCR Chinook salmon, UCR spring-run Chinook salmon, SR spring/summer-run Chinook salmon, UWR spring-run Chinook salmon, SR fall-run Chinook salmon, CR chum salmon, LCR coho salmon, SR sockeye salmon, LCR steelhead, MCR steelhead, UCR steelhead, SR steelhead, UWR steelhead, southern green sturgeon, and Pacific eulachon are at a low level of persistence or at risk of extinction. Individuals from all ESA-listed populations are likely to move through or utilize the action area at some point during their life history.

Factoring the current environmental baseline, fish from the component populations that move through and/or use the action area encounter habitat conditions that have been degraded by: restricted natural flows, reduced water quality from substantial chemical pollution, loss of functioning floodplains and secondary channels, and loss of vegetated riparian areas and associated shoreline cover. The significance of the degradation is reflected in the limiting factors identified above including: habitat access to floodplain and secondary channels, degraded habitat, loss of spawning and rearing space, pollution, juvenile fish stranding, and increased predation. This highlights the importance of protecting current functioning habitat and limiting water quality degradation, minimizing entrainment, and reducing potential predation of ESA-listed fish.

Within this context, the proposed action would create an annual four-month physical disturbance in the water column, and redistribute material from the bottom of the CR. The modified bathymetry within the EMB would be maintained for the duration of the 5-year permit. These habitat alterations would cause displacement of a small number of adult and juvenile fish as they avoid the dredging operation, to avoid entrainment and elevated turbidity. In addition, fish would experience a short-term (months) reduction prey as the benthic biological productivity is reduced, and then re-establishes in the vicinity of the dredge prism. These alternations would occur each year of the 5-year permit, during the 120-day work window. Finally, entrainment of a few juvenile salmonids is reasonably likely to occur. The number of fish of any population affected by increased risk of predation, reduced growth/fitness, injury, or death is expected to be low, in each of the 5 years.

The last element in the integration of effects includes a consideration of the cumulative effects anticipated in the action area. Primarily, the recovery of aquatic habitat from the degraded baseline conditions is likely to be slow in most of the action area. Cumulative effects (from continued or increasing uses of the action area) are likely to have a negative impact on habitat conditions, which in turn may cause slight negative pressure on population abundance trends in the future.

However, even when we consider the current status of the threatened and endangered fish populations and degraded environmental baseline within the action area, the proposed action itself is not expected to affect abundance, distribution, diversity, or productivity of any of the component populations of the ESA-listed species. Neither baseline conditions or limiting factors would be degraded further. The effects of the action would be too minor to have a measurable impact on the affected populations. The proposed action would not reduce the abundance, productivity, spatial structure, or diversity of the affected populations. When combined with a degraded environmental baseline and additional pressure from cumulative effects, the proposed action would not appreciably reduce the survival or recovery any of the listed species considered in this opinion.

2.6.2 Critical Habitat

In the context of the status of designated critical habitat and the specific baseline conditions of PBFs in the action area, the proposed action would not: obstruct the passage of migrating fish, reduce cover, remove riparian vegetation, alter flows, destabilize the channel or change its characteristics, alter water temperature, or substantially reduce available forage. However, the proposed action would temporarily effect safe migration corridors, forage, and water quality PBFs within the action area. When considering the cumulative effects of non-federal actions, recovery of aquatic habitat is likely to be slow in most of the action area and cumulative effects from basin-wide activities are likely to have a slightly negative impact on the quality of critical habitat PBFs.

As a whole, the critical habitat for migration and rearing is functioning moderately under the current environmental baseline in the action area. The proposed action would have low-level and periodic but largely temporary effects on the PBFs for migrating and rearing salmonids, and estuarine areas for eulachon and green sturgeon. When considered as an addition to the baseline conditions, the proposed action is not likely to appreciably diminish the value of designated critical habitat for the conservation of subject species of this consultation.

2.7. 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: LCR Chinook salmon, UWR Chinook salmon, UCR spring-run Chinook salmon, SR spring/summer-run Chinook salmon, SR fall-run Chinook salmon, LCR coho salmon, SR sockeye salmon, CR chum salmon, LCR steelhead, UWR steelhead, MCR steelhead, UCR steelhead, SR steelhead, or southern DPS of eulachon or destroy or adversely modify their designated critical habitat, or the critical habitat of SDPS green sturgeon.

2.8. Incidental Take Statement

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

2.8.1 Amount or Extent of Take

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

The proposed dredging would take place when juvenile and/or adult individuals of LCR Chinook salmon, UWR Chinook salmon, UCR spring-run Chinook salmon, SR spring/summer-run Chinook salmon, SR fall-run Chinook salmon, LCR coho salmon, SR sockeye salmon, CR chum salmon, LCR steelhead, UWR steelhead, MCR steelhead, UCR steelhead, SR steelhead and Pacific eulachon are reasonably certain to be present. Incidental take caused by the adverse effects of the proposed action would include:

- Injury or death of juvenile salmonids and eulachon eggs or larvae to entrainment during suction dredging.
- Harm of juvenile salmonids from behavioral avoidance response to a temporary localized increased turbidity during dredging and disposal.
- Harm of juvenile salmonids from reduced prey availability.

Due to the variable number of fish that would be exposed in each year, and the inability to visually observe all forms of injury, or even death, among these species, a definitive number of ESA-listed fish that would be killed, injured, or otherwise adversely affected cannot be determined or predicted. Instead NMFS would use a habitat-based surrogate to account for the amount of take, which is called an “extent” of take.

For this proposed action, the extent of take (the potential for entrainment, being exposed to elevated turbidity and reductions in forage for juvenile salmonids, and eggs/larvae of Pacific eulachon) is directly related to the amount of time that the suction dredge is operating. Since the potential for ESA-listed fish to be entrained, exposed to elevated turbidity, and experience reduced foraging opportunities is most directly measured by the amount of time the dredge is actively operating, the extent of take identified for the proposed action has been related to the number of days of dredging per year.

For the proposed action, the extent of take is 120 days of dredging per calendar year for 5 years during IWWW; dredging operations that exceed 120 days or are outside of IWWW; and any probability increases of more individuals being exposed to the effects of the action described above. The number of days of dredging per year is a threshold for reinitiating the consultation. Exceeding this indicator for extent of take would trigger the reinitiation provisions of this opinion.

2.8.2 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.

2.8.3 Reasonable and Prudent Measures

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

1. Minimize incidental take by operating the dredge to avoid entrainment during dredging and in-water disposal.
2. Minimized incidental take by limiting turbid conditions.
3. Ensure completion of an annual monitoring and reporting program to confirm the take exemption for the proposed action is not exceeded, and that the terms and conditions in this incidental take statement are effective in minimizing incidental take.

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

1) The following terms and conditions implement RPM 1, minimize entrainment during dredging:
   a) The Port must ensure that during dredging and active pumping of sediment, the suction dredge would remain in contact with the river bottom to the maximum extent possible, and would be raised no more than 1 meter above the bottom for dredge clearing, so as to reduce the likelihood of pulling fish from the water column into the dredge.
   b) Ensure in-water work would be performed in accordance with permit conditions, which set timing restrictions for in-water work to November 1–February 28.
   c) Require dredge operators to limit the dredge prism and the volume of removed sediment to the minimum area necessary to achieve project goals.
   d) If a clamshell is used, require mechanical dredge operators to ensure that the clamshell is lowered to the bottom as slowly as feasible to allow ESA-listed fish to escape.
   e) Discharge material from the disposal pipeline at depths of at least -20 feet MLLW.

2) The following terms and conditions implement RPM 2, minimize turbidity during dredge disposal:
   a) The Port must ensure turbidity remains at background levels 300 feet downstream during dredging and placement operations by adhering to dredge management protocols including monitoring and compliance reporting of turbidity levels observed during dredging operations.
      i) Limit sediment removal to no more than 144,348 cubic yards.
      ii) Adjust dredging operations to ensure that visible turbidity plumes do not exceed 300 feet from the project site, and to halt work should the visible turbidity plume approach or exceed that maximum.
      iii) If turbidity levels are to exceed the standards as described in the Water Quality Certification for this project, install a floating silt curtain around the in-water dredge area to minimize the dispersion of suspended sediment thereby reducing turbidity.

3) The following terms and conditions implement RPM 3, monitoring and reporting:
   a) The applicant shall submit a monitoring report to NMFS by March 31 of each year summarizing the following for the previous calendar year:
      i) The number of days dredging occurred each month and corresponding volume dredged.
      ii) The depth, volume, and area of dredging conducted for the calendar year.
      iii) Whether turbidity compliance criteria were met.
   b) Monitoring reports shall be submitted to:
      projectreports.wcr@noaa.gov

Attn: Include WCR tracking number (WCRO-2022-01674) in the subject line when the reports are submitted.

2.9. Conservation Recommendations

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

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

1) Regularly require the use floating silt curtains around the in-water dredge area to minimize the dispersion of suspended sediment thereby reducing turbidity.
2) Narrow the conditions under which maintenance dredging is allowed so that habitat values can completely recover between dredge occurrences. Dredging would not be allowed annually, without a showing that sediment accumulation is occurring or has occurred that threatens to impair safe mooring of vessels.
3) The USACE should consult with NMFS under Section 7(a)(1) to create a mitigation bank to offset impacts associated with the regular exercise of its authority allowing impacts to the nation's waters.

Please notify NMFS if the USACE carries out either of these recommendations so that we would be kept informed of actions that are intended to improve the conservation of listed species, or their designated critical habitats.

2.10. Species Not Likely to be Adversely Affected

Green Sturgeon. No green sturgeon are likely to be present within the action area during the IWWW. Green sturgeon are not known to use the estuary habitat for rearing except during the summer and early fall months (Moser & Lindley, 2007). As cited by these authors, commercial catch of green sturgeon peaks in October in the CR estuary. Records from other estuarine fisheries (Willapa Bay and Grays Harbor, Washington) support the idea that sturgeon are only present in these estuaries from June until October. However, comprehensive fishery sampling has not been conducted year-round in the CR estuary. If Green sturgeon that were present in the action area during the IWWW are likely to be larger sub-adults, able to avoid the dredge head avoiding entrainment.

Green sturgeon, if they were present in the mainstem CR, could encounter the turbid conditions created by the proposed action. Green sturgeon are typically found in turbid conditions and forage in the benthos by stirring up the sediment to access benthic prey (burrowing shrimp). This means they are relatively tolerant of higher suspended sediment concentrations. As such, in the unlikely event that green sturgeon are present to encounter elevated TSS related to the project, effects are not expected to rise to the level of take. This conclusion is supported further by recent results in the closely related Atlantic sturgeon, wherein juveniles were experimentally exposed to

100, 250 or 500 mg/L of TSS for three consecutive days (Wilkens et al., 2015). The fish were found to exhibit no significant effects on survival or swimming performance even while prevented from seeking cleaner waters in the tests. According to LaSalle et al. (1991), within 300 feet of dredging fine silt or clay, the expected TSS would be approximately 700–1,100 mg/L at the surface and bottom of the water column. Lower concentrations are expected in the action area because the sediment is composed of sand and silt which settles quickly. They are however, extremely unlikely to be present and exposure is not expected.

2.11. Reinitiation of Consultation

This concludes formal consultation for Port of Astoria East Mooring Basin Maintenance Dredging.

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

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

Section 305(b) of the MSA directs Federal agencies to consult with NMFS on all actions or proposed actions that may adversely affect EFH. Under the MSA, this consultation is intended to promote the conservation of EFH as necessary to support sustainable fisheries and the managed species' contribution to a healthy ecosystem. For the purposes of the MSA, EFH means "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity", and includes the physical, biological, and chemical properties that are used by fish (50 CFR 600.10). Adverse effect means any impact that reduces quality or quantity of EFH, and may include direct or indirect physical, chemical, or biological alteration of the waters or substrate and loss of (or injury to) benthic organisms, prey species and their habitat, and other ecosystem components, if such modifications reduce the quality or quantity of EFH. Adverse effects on EFH may result from actions occurring within EFH or outside of it and may include site-specific or EFH-wide impacts, including individual, cumulative, or synergistic consequences of actions (50 CFR 600.810). Section 305(b) of the MSA also requires NMFS to recommend measures that can be taken by the action agency to conserve EFH. Such recommendations may include measures to avoid, minimize, mitigate, or otherwise offset the adverse effects of the action on EFH (CFR 600.905(b)).

This analysis is based, in part, on the EFH assessment provided by the USACE and that conducted by NMFS, and descriptions of EFH for Pacific Coast groundfish, coastal pelagic species (CPS), Pacific Coast salmon and highly migratory species contained in the fishery management plans developed by the PFMC and approved by the Secretary of Commerce (PFMC, 1998; 2005; 2007; 2014). In this case, NMFS concluded the proposed action would not adversely affect EFH for CPS and highly migratory species. Thus, consultation under the MSA is not required for these habitats.

3.1. Essential Fish Habitat Affected by the Project

The proposed action may have an adverse effect on EFH designated for Pacific Coast salmon, and Pacific Coast groundfish, specifically the habitat areas of particular concern (HAPC) which include, coastal and estuary habitats. The effects of the proposed action on EFH are the same as those described above in the ESA portion of this document and NMFS concurs with the findings in the EFH statement.

3.2. Adverse Effects on Essential Fish Habitat

As described in detail in the preceding opinion, the proposed action is expected to affect EFH components in the mainstem CR. We conclude that the proposed action would have the following adverse effects on EFH designated for Pacific Coast salmon, and Pacific Coast groundfish:

1. The proposed dredging disposal activities would temporarily decrease water quality. This entails suspended sediments, the mobilization of contaminants, and potentially, lower dissolved oxygen levels.

2. The proposed dredging would disturb benthic habitat and reduce the quantity and quality of benthic prey communities.

Overall, the area of disturbance is relatively small in relation to the CR estuary. It is partially isolated from the mainstem CR and the disturbance would be temporary. The current conditions would be maintained in the action area and the action would not change the functional characteristics of the habitat.

3.3. Essential Fish Habitat Conservation Recommendations

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

The effects of the proposed dredging activity would be contained and turbidity minimized by use of the suction dredge and monitoring and controlling discharge of return waters at the material disposal site. To minimize the effects of the proposed dredging and disposal activities on Pacific Coast salmon and Pacific Coast groundfish EFH including the estuaries HPAC, the USACE should:

1. Require vessel operators to operate at the lowest safe maneuvering speeds and power settings when maneuvering in waters close to the shoreline.
2. To reduce effects on the benthic prey eaten by salmonids and juvenile groundfish, conduct before and after macro-benthic community structure analysis within the EMB

dredge prism to determine the benthic community response (taxa, diversity, richness, and abundance) at 1, 3, and 6 months following the dredging. Work with NMFS to identify opportunities for this type of monitoring for future side channel dredging projects. Based on findings, adjust frequency of dredging to accommodate prey recolonization rates.

Fully implementing these EFH conservation recommendations would protect, by avoiding or minimizing the adverse effects described in section 3.2, above, approximately 40 acres of designated EFH and HAPC for the habitat of Pacific Coast salmon and Pacific Coast groundfish.

3.4. Statutory Response Requirement

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

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

3.5. Supplemental Consultation

The 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 users of this opinion are USACE. Other interested users could include the Port of Astoria and Campbell Environmental LLC. 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 contain more background on information sources and quality.

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

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

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