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-2020-01858

June 24, 2021

Daniel M. Mathis, P.E.
Division Administrator, Washington Division
Federal Highway Administration
711 South Capitol Way, Suite 501
Olympia, Washington 98501-1284

Re: Endangered Species Act Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response for the Interstate 5/East Fork Lewis River Bridge Northbound – Replacement Project, Clark County, Washington (East Fork Lewis River, HUC_5 1708000205)

Dear Mr. Mathis:

Thank you for your letter of July 7, 2020, 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 Federal Highway Administration's (FHWA) proposed Interstate 5 (I-5)/East Fork Lewis River Bridge Northbound Replacement Project in Clark County, Washington. 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.

This consultation was conducted in accordance with the 2019 revised regulations that implement section 7 of the ESA (50 CFR 402, 84 FR 45016). The enclosed document contains the biological opinion (Opinion) prepared by the NMFS pursuant to section 7 of the ESA on the effects of the proposed action. In this Opinion, the NMFS concludes that the proposed action would adversely affect but is not likely to jeopardize the continued existence of Lower Columbia River (LCR) Chinook salmon, LCR coho, LCR steelhead, Columbia River (CR) chum, and eulachon. The NMFS also concludes that the proposed action is likely to adversely affect designated critical habitat for LCR Chinook, LCR coho, LCR steelhead, CR chum and Pacific eulachon but is not likely to result in the destruction or adverse modification of that designated critical habitat. This document also documents our conclusion that the proposed action is not likely to adversely affect southern resident (SR) killer whales and their designated critical habitat.

This Opinion includes an incidental take statement (ITS) that describes reasonable and prudent measures (RPMs) the NMFS considers necessary or appropriate to minimize the incidental take associated with this action, and sets forth nondiscretionary terms and conditions that the FHWA must comply with to meet those measures. Incidental take from actions that meet these terms and conditions will be exempt from the ESA's prohibition against the take of listed species.

Section 3 of this document includes our analysis of the action's likely effects on EFH pursuant to Section 305(b) of the MSA. Based on that analysis, the NMFS concluded that the action would adversely affect designated EFH for Pacific Coast Salmon. Therefore, we have provided 3 conservation recommendations that can be taken by the FHWA 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 this recommendation.

Please contact Scott Hecht in the Washington Coast-Lower Columbia Branch of the Oregon Washington Coastal Office at 360-534-9306 or by electronic mail at Scott.Hecht@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: Angie Haffie, WSDOT
Emma Huston, WSDOT
Cindy Callahan, FHWA
Gary Martindale, FHWA

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

Interstate 5/East Fork Lewis River Bridge Northbound – Replacement Project
Clark County, Washington (Fifth-field HUC 1708000205, East Fork Lewis River)

NMFS Consultation Number: WCRO-2020-01858

Action Agency: Federal Highway Administration

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 steelhead (*Oncorhynchus mykiss*)	Threatened	Yes	No	Yes	No
Lower Columbia River Chinook salmon (*O. tshawytscha*)	Threatened	Yes	No	Yes	No
Columbia River chum salmon (*O. keta*)	Threatened	Yes	No	Yes	No
Lower Columbia River coho salmon (*O. kisutch*)	Threatened	Yes	No	Yes	No
Pacific eulachon (*Thaleichthys pacificus*)	Threatened	Yes	No	Yes	No
Southern Resident killer whales (*Orcinus orca*)	Endangered	No	No	No	No

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

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

Issued By:

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

Date: June 24, 2021

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1. INTRODUCTION

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

1.1 Background

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

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

We completed pre-dissemination review of this document using standards for utility, integrity, and objectivity in compliance with applicable guidelines issued under the Data Quality Act (DQA) (section 515 of the Treasury and General Government Appropriations Act for Fiscal Year 2001, Public Law 106-554). The document will be available within two weeks 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

On September 19, 2019, an early coordination meeting was attended by representatives from the NMFS, U.S. Fish and Wildlife Service (FWS), and Washington State Department of Transportation (WSDOT) (applicant). In anticipation of the request for consultation, on June 18, 2020, the NMFS suggested that the Federal Highway Administration (FHWA) and WSDOT include the Southern Resident Killer Whale (SRKW) in the request due to the potential for adverse effects to Chinook salmon, prey species for SRKWs that are themselves at risk of extinction. We listed this species as endangered on November 18, 2005 (70 FR 6993). On July 1, 2020, the FHWA responded that they will not proactively analyze those effects until a time after further discussion and coordination with NMFS.

On July 9, 2020, NMFS received a request to initiate ESA section 7 consultation and the initiation package from the FHWA. The initiation package included an ESA section 7 consultation initiation letter and biological assessment (BA), including detailed construction and stormwater discharge plan sheets. The FHWA determined the action may affect and is likely to adversely affect (LAA) Lower Columbia River (LCR) Chinook salmon, LCR coho, Columbia River (CR) chum, LCR steelhead, and their designated critical habitats. They also determined that the project may adversely affect EFH and requested concurrence that the project is not likely to adversely affect Pacific eulachon (eulachon) and its designated critical habitat.

The NMFS received additional information requested to clarify material provided in the BA, and on July 31, 2020, formal consultation was initiated for potential effects to LCR Chinook, LCR coho, CR chum, LCR steelhead, and their designated critical habitat. On October 19, 2020, NMFS was informed that significant design changes would be provided by the applicant and the consultation timeline was paused as mutually agreed upon with the FHWA and WSDOT. On February 12, 2021 the effect call for eulachon was discussed with WSDOT and FHWA and it was mutually agreed to change the effect determination to may affect, likely to adversely affect eulachon and its designated critical habitat. All updated information required to complete consultation was also received on that date; therefore, the consultation timeline was restarted and the completion date was recalculated.

The FHWA did not request to consult on SRKWs. Therefore, NMFS has considered the effects of this action on SRKWs in Section 2.12. There is proposed designated critical habitat for SRKW down river of the action area, and LCR spring Chinook salmon are a biological feature of that proposed critical habitat.

1.3 Proposed Federal Action

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

The FHWA will provide funding under the National Highway Performance Program [(NHPP) FAST Act § 1106; 23 U.S.C. 119)] to the WSDOT to replace the existing northbound three-lane bridge on Interstate 5 (I-5) between milepost (MP) 17.2 and MP 19.0 in Clark County, Washington (Figure 1). The project will also require Section 10 of the Rivers and Harbors Act (33 U.S.C. 403) and Section 404 of the Clean Water Act (33 U.S.C. 1344) permits to be issued by the U.S. Army Corps of Engineers (COE). The purpose of the proposed project is to replace the deteriorating structure with a structurally sufficient bridge, thereby improving safety, and reducing maintenance events.

The northbound I-5 bridge crosses the East Fork Lewis River at approximately river mile 0.75, northwest of the City of La Center. The project is located in Township 5 north, Range 1 east, and Section 9. The project site is located within fifth-field hydrologic unit code (HUC_5) 1708000205 (East Fork Lewis River) and Water Resource Inventory Area 27 (Lewis River).

The project is being delivered by WSDOT, on behalf of FHWA, as a design-build project. While some information on construction timing, sequencing and environmental performance measures will be specified as conditions in the project contract, construction means and methods will be largely left to the contractor. This document contains a summary of the proposed action and associated activities with the potential to effect listed species. A detailed description of the proposed action is contained in the Biological Assessment (BA) and supporting documentation provided to the NMFS by the FHWA.

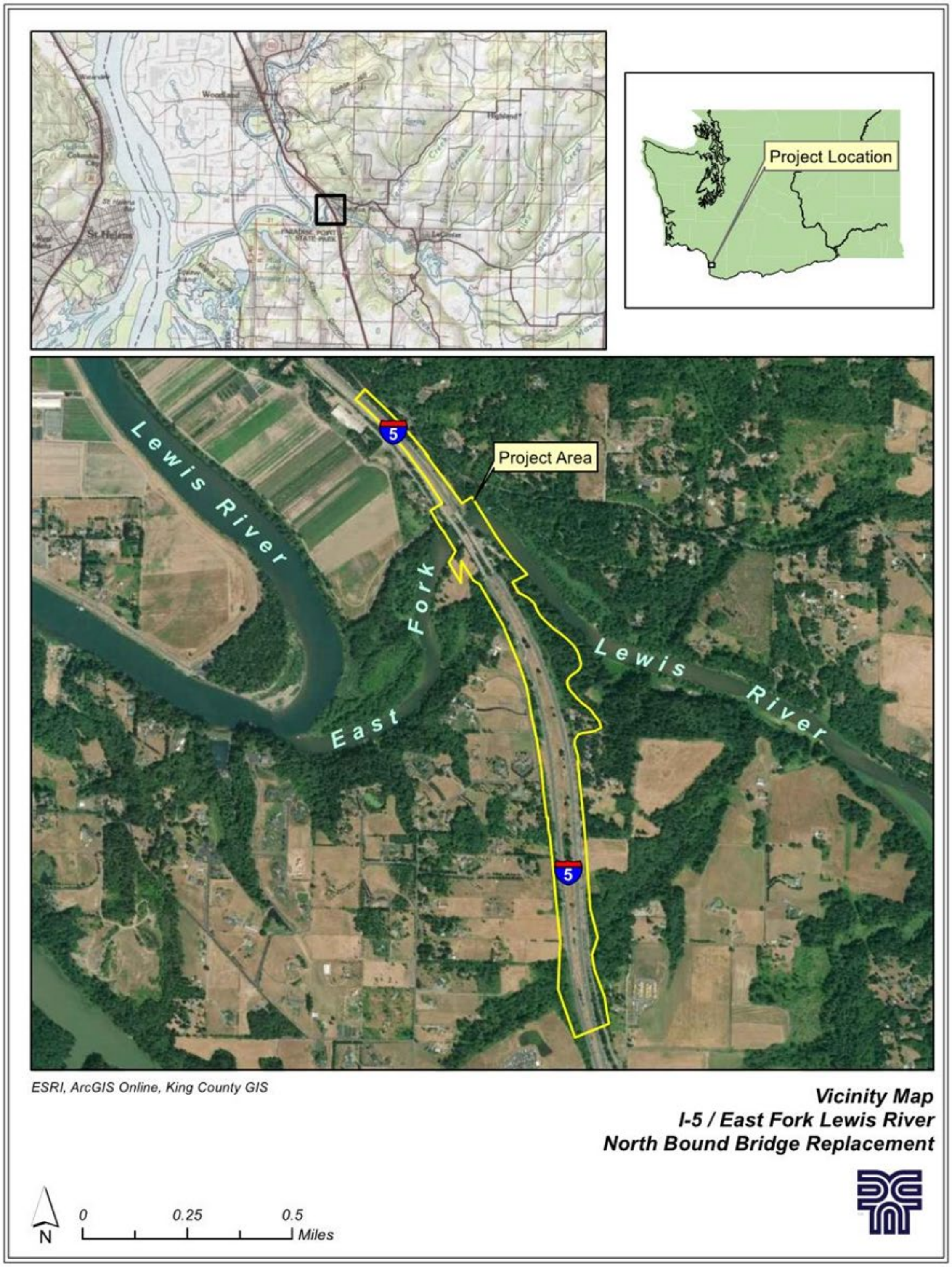

Figure 1. Overview of Project Location

The project will begin as early as March 2022 and will be completed in December 2025. Pre-construction activities include mobilization, staging, installation of erosion control best management practices (BMP's), and clearing and grubbing. Staging will be located south of the river channel on the east and west sides of the bridge and occupy up to 4 acres. Staging areas on the west side of the bridge are within Paradise Point State Park. Day use and camping areas will be closed during the duration of the construction, so on-site staging will likely be in place throughout the project duration. The access road to the State Park will be used by heavy equipment and approximately 1.6 acres of pavement will be repaired at the completion of the project.

The new bridge will replace the existing structure, either in the same location, on the current I-5 alignment, or on a new alignment slightly to the west, immediately adjacent to the existing location. Ultimately, the post-project permanent replacement over the East Fork Lewis River will include a bridge deck that is approximately 895 feet long by 63 feet wide and will be supported on six piers. The bridge will have three northbound lanes of 12 feet per lane, 10 foot shoulders, and 7 feet for bridge barriers and railings. The paved roadway width will increase from 48 feet to 56 feet to increase the shoulder width by 4 feet on each side; the travel-lane width will not change. The approaches at the north and south ends of the bridge will be replaced and raised. The new bridge is proposed to span the river approximately 206 feet, based on use of a pre-stressed girder that is has a maximum length of 225 feet; thereby necessitating placement of two piers near or slightly below the ordinary high water mark (OHWM), similar to where the existing piers are located. It is anticipated that new bridge layout and associated permanent impacts will be located within the existing WSDOT right of way.

The use of temporary demolition support piles, temporary work platforms, and a geosynthetic retaining wall will be needed for either alignment, requiring installation of 84 steel piles below the OHWM, and 12 piles above the OHWM. Demolition support piles will be installed to support the weight of the existing steel truss structure. Three temporary work platforms will be constructed and used for the demolition of the existing steel truss structure and the construction of the new bridge. A geosynthetic retaining wall is needed at the north river pier to create a level, compacted surface for construction equipment. The temporary steel piles required for these structures are expected to remain in place over the entire project construction period of four years. The temporary work platforms will create 6,500 feet^2 of shade over the East Fork Lewis River throughout construction. The minimum clearance between the elevation of the OHWM and the underside of the work platform decks is based on constructability and is currently unknown. For navigation purposes, as required by the U.S. Coast Guard (USCG), there will be at least 20 feet of clearance between the elevation of the OHWM and the underside of the work platform(s) within the river thalweg and at least 36.5 feet of horizontal clearance. The minimum clearance of the final bridge is between 43 and 53 feet.

Geotechnical exploration identified soft soils requiring ground improvements to support the bridge abutments from liquefaction. Deep soil mixing (DSM) with supplemental jet grouting is the most likely option on this project. DSM is a ground improvement technique where in-place soils are mixed or blended with cementitious materials and other additives (e.g., lime or fly ash) resulting in columns of soil-cement with significantly increased strength and reduced compressibility. Metered quantities of additives are injected into the soil through the hollow stem of a rotary drill string fitted to a drill rig. The drill advances a mixing tool as slurry is pumped, mixing the soil to the target depth. Additional mixing of the soil is completed as the tool is withdrawn to the surface. The columns are often installed in an interlocking grid pattern. DSM is generally quiet and free of vibrations. Some spoils and excess soil-cement may be generated.

Jet grouting is a targeted/selective ground improvement technique where a hole is drilled to the desired depth, and a jet grouting string with a nozzle is raised and rotated while injecting a liquid cement slurry at a high pressure/velocity to mix the in-place soils and form a column of soil-cement. Jet grouting generally creates more spoils, or grout/soil mixture returning to the ground surface, than DSM. Spoils could be collected while wet using vacuum trucks or allowed to cure in a trench or pit and then removed with an excavator.

Approximately 0.7 acres of ground improvements are required, with the majority occurring above OHW. The total area of ground improvements below the OHWM is estimated to be 1,600 feet^2 at the south bank pier. It is expected that this area will be dry during the installation. However, a cofferdam will be installed in order to prevent water quality impacts from grout and to isolate the work area from surface water and groundwater intrusion. This cofferdam will isolate a maximum of 10,000 ft^2 of aquatic habitat and will remain in place for the work described below at the south bank pier. All high-pH waste material produced as a result of the ground improvements will be collected, removed, and taken to an approved off-site location.

All work at the south bank pier is below the OHWM and will require work isolation. Due to the proposed location of the north bank pier and the OHWM, if the work cannot occur during periods of low water installation will also require the use of cofferdams. Similar to the use of cofferdams for the installation of new permanent piers, cofferdams would also be used for demolition of the existing piers. The most effective isolation method would use sheet piles driven with a vibratory pile driver. Sheet piles would isolate a maximum of 10,000 square feet of aquatic habitat at each pier for a total maximum of 20,000 ft^2. The current construction schedule shows the cofferdam(s) being installed in summer 2022 and to remain until summer 2024. Leaving the cofferdam(s) in place over two winter seasons will reduce the impacts of installing the cofferdam twice in the same location.

Once isolated, the dammed area(s) will be dewatered and fish will be removed. Fish exclusion activities will follow the most recent WSDOT protocol that has been approved by the NMFS and USFWS, and may reoccur if the cofferdams are over-topped by high flows.

Regardless of alignment choice, the design-builder may choose to use a spliced girder rather than a pre-stressed girder. This design option will require six temporary piers to support the construction of the permanent bridge. There will be 18 steel piles per pier and two of the temporary piers are below OHW.

The length of the south approach and the total number of steel piles needed are each dependent upon which alignment is chosen. Using the existing alignment will require construction of a temporary traffic bridge, thereby increasing the in-water construction impacts. The temporary traffic bridge will require up to 180 steel piles, and up to 30 piles will be below OHW. There will be at least 25 feet of clearance between the elevation of the OHWM and the underside of the temporary traffic bridge.

Constructing the bridge on a new alignment will require the approach on the southern end to extend an additional 2,500 feet, and has a larger stormwater footprint due to enhanced runoff treatment required for the increased amounts of new pollution generating impervious surface (PGIS). Regardless of the alignment selected, there is a very small net increase in total PGIS, because the existing and new bridges are similar in size. The action includes BMPs for effective treatment and removal of pollutants for all of the new PGIS (relative to the existing bridge) up to a maximum of 5.3 equivalent acres of treatment. The on-alignment scenario has less new PGIS, thereby providing a lower level of enhanced stormwater runoff treatment (up to a maximum of 0.24 acre), and is the worst case stormwater scenario.

Post-treatment stormwater is expected to discharge through existing stormwater pipes and/or drainage ditches beneath the bridge into the East Fork Lewis River. Detention ponds or other forms of flow control are not proposed because no measurable hydrologic or hydraulic changes are expected due to large water volumes, a relatively flat stream gradient, and tidal influence at the discharge location. Section 2.6 in the BA (pp. 18-21) provides a detailed discussion of the potential stormwater scenarios, treatment, and BMPs, and a thorough stormwater analysis is provided throughout the BA.

In-water work is projected to occur for a duration of four years, beginning in July 2022 and ending by October 31, 2025. All pile installation will occur over two in-water work periods (in 2022 and 2023). Impact pile driving will occur during the daytime only, will implement a 12-hour daily rest period (overnight), and will employ a bubble curtain or other equivalent noise attenuation device around each pile in waters more than 3-feet deep[1]. The work window for impact pile driving was shortened at the request of NMFS to July 1 through September 30 in order to reduce the potential adverse effects to migrating salmonids, particularly late-run coho and fall Chinook.

Impact driving of steel piles is proposed for the construction of temporary work platforms/demo support/geosynthetic wall (up to 84 piles), temporary bridge piers (up to 36 piles), and possibly a temporary traffic bridge (up to 30 piles) below the OHWM for a maximum of 150 temporary piles. Up to 100 permanent 30-inch diameter steel piles will be driven with an impact hammer for the two piers located near/below the OHWM, unless drilled shafts are used instead. All piles will be driven with a vibratory hammer to the point of resistance, limiting the number of impact strikes necessary, and all temporary piles will be removed with a vibratory hammer. Not all piles will be driven and removed in the same in-water work season. Impact pile driving will occur over two years (2022 and 2023) and vibratory removal will occur in a separate year (2025). Table 2 in the BA (FHWA 2020, p. 11) and supplemental information provided identify the maximum numbers of piles each year.

[1] In water 3 feet deep or less, low frequency sound waves do not propagate through the water because the sounds have wavelengths greater than 3 feet. Since most of the sound energy from impact pile-driving is low frequency, it will not propagate through shallow water. (Communication with Jim Laughlin, June 25, 2020. Based on Urick, 1983).

Piles require proofing with the impact hammer in order to achieve and verify structural criteria when structural criteria cannot be reached using the vibratory hammers only. Pile installation is proposed at a rate of 2 to 3 piles per day, requiring a maximum of 300 impact strikes per pile, although this could be significantly fewer. The FHWA and WSDOT propose allowance for a maximum of 900 impact strikes per day during the July 1 to September 30 window in 2022 and 2023.

The old bridge will be demolished at the appropriate stage in sequencing, depending on the selected alignment, without a disruption of traffic. Modular barges to contain the bridge demolition will likely be built on and installed from the two temporary work platforms. A barge(s) located in shallow water may ground on the substrate. The platforms are also expected to be used to place a combination of a crane and demolition excavator or equivalent types of equipment to remove the bridge. A crane would remove bridge pieces, and place them either within right-of-way areas above the OHWM or in modular barges to prevent exposure of surface waters to asphalt, painted bridge surfaces, and other potentially toxic materials associated with bridge debris. The concrete deck will be removed, followed by the steel truss members. Once the span over the river has been removed, the remaining deck, girders, and piers/bents will be removed. A containment system adequate to prevent construction debris from entering the East Fork Lewis River will be installed.

No new in-water work is expected to occur in 2024, but all temporary structures within the river channel will remain. All temporary piles that support bridge construction or demolition, will be removed in 2025, including both upland and river channel piles.

Wetland vegetation will be removed and six wetlands will be filled within the floodplain for the bridge footprint and at the constructed staging area, totaling approximately 2.6 acres. Most of the delineated wetlands are high quality Category I riverine systems that include forested, scrub shrub, and emergent components. Approximately 1.4 acres of the area to be altered is composed of mowed emergent areas at the edge of landscaped portions of the state park. Individual wetland impacts are reported in in the BA (FHWA 2020, p. 30; Figure 7, p. 33). Mitigation for wetland impacts will occur at the Columbia River Mitigation Bank located near the Port of Vancouver, and FHWA and WSDOT will explore potential on-site restoration opportunities with Washington State Parks or other conservation agencies.

Riparian vegetation within the WSDOT right of way between the two existing bridges, under the northbound bridge, and along existing roads that serve the state park will be removed, totaling approximately 1.03 acres. The habitat is densely vegetated with mature trees and understory vegetation consisting of willow (*Salix* spp.), black cottonwood (*Populus trichocarpa*), Douglas fir (*Pseudotsuga menziesii*), big leaf maple (*Acer macrophyllum*), Oregon ash (*Fraxinus latifolia*), Oregon white oak (*Quercus garryana*), and red osier dogwood (*Cornus sericea*). Various grasses, both native and cultivated, as well as invasive Scotch broom (*Cytisus scoparius*) and Himalayan blackberry (*Rubus armeniacus*) are also present. Revegetation of riparian areas will occur after bridge construction is completed

On-site post project restoration will take place through December 2025. The project will restore all disturbed areas with native woody and herbaceous vegetation to provide permanent slope stabilization, restore and enhance environmental function, buffer sensitive areas, restore soil porosity and infiltration, maintain corridor and state park visual continuity, and integrate the project into the surrounding landscape per WSDOT Roadside and Environmental Policy and applicable environmental permits.

There are a wide variety of upland components and activities associated with the proposed action that are not discussed here, but can be found in the BA (FHWA 2020, pp. 3-22) and supplemental documentation provided. WSDOT activities are subject to federal, state, and local permit regulations. The FHWA and WSDOT have developed and routinely use the best guidance available (BMP's and minimization measures) to avoid and minimize (to the greatest extent possible) impacts on the environment, ESA listed species, and designated critical habitats. The full list of minimization measures can be found in the BA (FHWA 2020, pp. 23-24).

We considered, under the ESA, whether or not the proposed action would cause any other activities and determined that it would not. Replacing the existing bridge it is not expected to result in increased traffic volumes or speed limits, or cause land use changes outside of projected growth in the area, but will reduce the amount and frequency of future maintenance. Future bridge maintenance will be covered under the Region Road Maintenance Program (Limit 10 of the 4(d) Rule, NMFS Tracking No. 2003/00313) or will undergo separate Section 7 consultation.

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).

For the proposed action, there are both short-term construction-related effects and long-term structure-related effects. The terrestrial action area is based on the geographic extent of in-air sound and was conservatively evaluated to ambient noise levels in the absence of traffic. In-air construction sound is expected to attenuate to ambient noise levels of 50 dBA L_{eq}[2] (re: 20 µPa and applies to all in air sound levels) within 12,560 feet (2.38 miles). This distance is based on noise levels generated during impact pile driving. Most construction noise (at or below 92 dBA L_{max}[3]) will be expected to attenuate to ambient traffic noise levels of 81 dBA L_{max} within 629 feet (0.12 mile).

The area of effect within the aquatic portion of the action area for this proposed federal action is based on the geographic extent of elevated noise in the East Fork Lewis River from impact pile driving. Potential behavioral effects from noise are calculated to occur 2.9 miles from the source; however, noise will be blocked upon reaching a topographic barrier. Meanders are present within the river approximately 0.25 miles (1,320 feet) upstream and downstream of piles to be driven. Therefore, the aquatic action area extends 0.25 mile upstream and downstream for a total of 0.5 mile (Figure 2).

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[2] L_{eq} = equivalent sound pressure level: the steady noise level that, over a specified period of time, would produce the same energy equivalence as the fluctuating noise level actually occurring.
[3] L_{max} = highest A-weighted sound level occurring during a noise event during the time that noise is being measured.

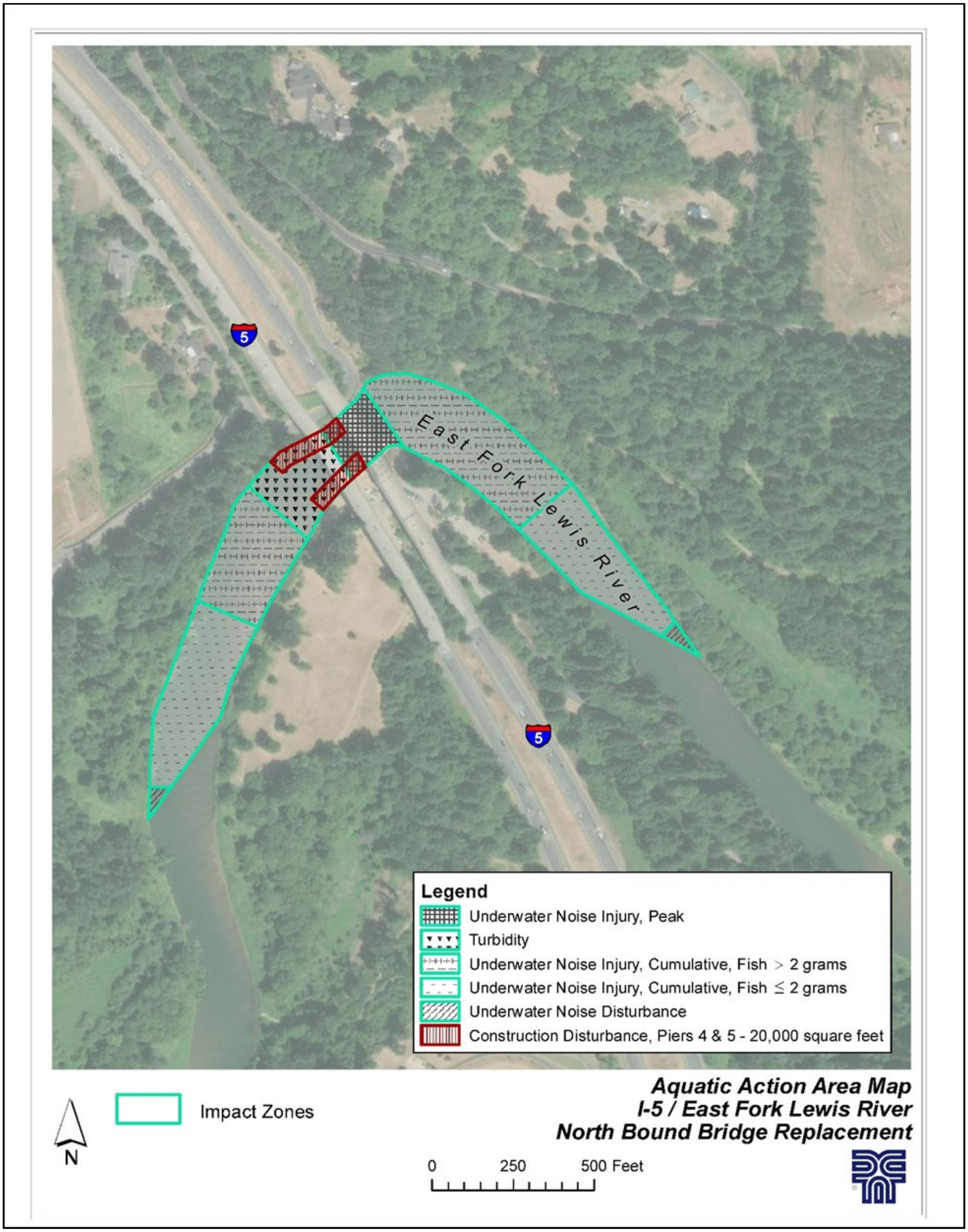

Figure 2. Aquatic Action Area

Project generated turbidity is expected to return to background conditions within 300 feet of the downstream extent of streambed disturbance. The extent of potential stormwater discharges during construction are captured within this distance. The extent of physical, chemical or biological effects post construction is associated with likely impacts of permanent water quality effects due to the discharge of stormwater. Because no method of treatment other than full infiltration will fully remove all contaminants, stormwater discharges will be a chronic source of episodic chemical load into the salmonid and eulachon bearing waterbody. While the State of Washington's water quality regulations assumes the additional load becomes indistinguishable from the background level at the end of the mixing zone, downstream from the discharge point, it is certain that the additional load of contaminants will be transported down to the confluence with the mainstem Lewis River and possibly beyond.

The described action area overlaps with the geographic ranges of the ESA-listed species and the boundaries of designated critical habitats identified in Table 1. The action area also overlaps with areas that have been designated, under the MSA, as EFH for Pacific Coast salmon. The effects to EFH are analyzed in the MSA portion of the document.

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

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

As described in section 1.2, the FHWA determined that the proposed action would adversely affect LCR Chinook salmon, LCR coho, CR chum, LCR steelhead, eulachon and designated critical habitat for these species (Table 1). Although not requested by FHWA, we have independently analyzed that the proposed action is not likely to adversely affect SRKWs based on adverse effects to their prey, which are vital to their recovery. The analysis is documented in the "Not Likely to Adversely Affect" Determinations section (2.12).

Table 1. ESA-listed species and critical habitats that may be affected by the proposed action.

Species	Status	Species	Critical Habitat	Listed / Critical Habitat Designated
Chinook salmon (*Oncorhynchus tshawytscha*) Lower Columbia River	Threatened	LAA	LAA	06/28/05 (70 FR 37160)/ 09/02/05 (70 FR 52629)
Coho salmon (*O. kisutch*) Lower Columbia River	Threatened	LAA	LAA	06/28/05 (70 FR 37160)/ 02/24/16 (81 FR 9251)
Chum salmon (*O. keta*) Columbia River	Threatened	LAA	LAA	06/28/05 (70 FR 37160)/ 09/02/05 (70 FR 52629)
Steelhead (*O. mykiss*) Lower Columbia River	Threatened	LAA	LAA	01/05/06 (71 FR 834)/ 09/02/05 (70 FR 52629)
Pacific eulachon (*Thaleichthys pacificus*) Southern	Threatened	LAA	LAA	03/18/10 (75 FR 13012)/ 10/20/11 (76 FR 65323)
Killer whales (*Orcinus orca*) Southern Resident	Endangered	NLAA	NA	02/10/15 (80 FR 7380)/ 11/29/06 (71 FR 69054)

N/A = not applicable. The action area is outside designated critical habitat

2.1 Analytical Approach

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

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

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

The 2019 regulations define effects of the action using the term "consequences" (50 CFR 402.02). As explained in the preamble to the regulations (84 FR 44977), that definition does not change the scope of our analysis and in this opinion we use the terms "effects" and "consequences" interchangeably.

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

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

2.2 Rangewide Status of the Species and Critical Habitat

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

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. The largest hydrologic responses are expected to occur in basins with significant snow accumulation, where warming decreases snow pack, increases winter flows, and advances the timing of spring melt (Mote et al. 2014; Mote et al. 2016). Rain-dominated watersheds and those with significant contributions from groundwater may be less sensitive to predicted changes in climate (Tague et al. 2013; Mote et al. 2014).

During the last century, average regional air temperatures in the Pacific Northwest increased by 1-1.4°F as an annual average, and up to 2°F in some seasons (based on average linear increase per decade; Abatzoglou et al. 2014; Kunkel et al. 2013). Recent temperatures in all but two years since 1998 ranked above the 20th century average (Mote et al. 2014). Warming is likely to continue during the next century as average temperatures are projected to increase another 3 to 10°F, with the largest increases predicted to occur in the summer (Mote et al. 2014).

Decreases in summer precipitation of as much as 30 percent by the end of the century are consistently predicted across climate models (Mote et al. 2014). Precipitation is more likely to occur during October through March, less during summer months, and more winter precipitation will be rain than snow (ISAB 2007; Mote et al. 2013). Earlier snowmelt will cause lower stream flows in late spring, summer, and fall, and water temperatures will be warmer (ISAB 2007; Mote et al. 2014). Models consistently predict increases in the frequency of severe winter precipitation events (i.e., 20-year and 50-year events), in the western United States (Dominguez et al. 2012). The largest increases in winter flood frequency and magnitude are predicted in mixed rain-snow watersheds (Mote et al. 2014).

The combined effects of increasing air temperatures and decreasing spring through fall flows are expected to cause increasing stream temperatures; in 2015 this resulted in 3.5-5.3ºC increases in Columbia Basin streams and a peak temperature of 26ºC in the Willamette (NWFSC 2015). Overall, about one-third of the current cold-water salmonid habitat in the Pacific Northwest is likely to exceed key water temperature thresholds by the end of this century (Mantua et al. 2009).

Higher temperatures will reduce the quality of available salmonid habitat for most freshwater life stages (ISAB 2007). Reduced flows will make it more difficult for migrating fish to pass physical and thermal obstructions, limiting their access to available habitat (Mantua et al. 2010; Isaak et al. 2012). Temperature increases shift timing of key life cycle events for salmonids and species forming the base of their aquatic foodwebs (Crozier et al. 2011; Tillmann and Siemann 2011; Winder and Schindler 2004). Higher stream temperatures will also cause decreases in dissolved oxygen and may also cause earlier onset of stratification and reduced mixing between layers in lakes and reservoirs, which can also result in reduced oxygen (Meyer et al. 1999; Winder and Schindler 2004; Raymondi et al. 2013). Higher temperatures are likely to cause several species to become more susceptible to parasites, disease, and higher predation rates (Crozier et al. 2008; Wainwright & Weitkamp 2013; Raymondi et al. 2013).

As more basins become rain-dominated and prone to more severe winter storms, higher winter stream flows may increase the risk that winter or spring floods in sensitive watersheds will damage spawning redds and wash away incubating eggs (Goode et al. 2013). Earlier peak stream flows will also alter migration timing for salmon smolts, and may flush some young salmon and steelhead from rivers to estuaries before they are physically mature, increasing stress and reducing smolt survival (McMahon and Hartman 1989; Lawson et al. 2004).

In addition to changes in freshwater conditions, predicted changes for coastal waters in the Pacific Northwest as a result of climate change include increasing surface water temperature, increasing but highly variable acidity, and increasing storm frequency and magnitude (Mote et al. 2014). Elevated ocean temperatures already documented for the Pacific Northwest are highly likely to continue during the next century, with sea surface temperature projected to increase by 1.0-3.7ºC by the end of the century (IPCC 2014). Habitat loss, shifts in species' ranges and abundances, and altered marine food webs could have substantial consequences to anadromous, coastal, and marine species in the Pacific Northwest (Tillmann and Siemann 2011; Reeder et al. 2013).

Moreover, as atmospheric carbon emissions increase, increasing levels of carbon are absorbed by the oceans, changing the pH of the water. A 38 percent to 109 percent increase in acidity is projected by the end of this century in all but the most stringent CO_2 mitigation scenarios, and is essentially irreversible over a time scale of centuries (IPCC 2014). Regional factors appear to be amplifying acidification in Northwest ocean waters, which is occurring earlier and more acutely than in other regions and is already impacting important local marine species (Barton et al. 2012; Feely et al. 2012). Acidification also affects sensitive estuary habitats, where organic matter and nutrient inputs further reduce pH and produce conditions more corrosive than those in offshore waters (Feely et al. 2012; Sunda and Cai 2012).

Global sea levels are expected to continue rising throughout this century, reaching likely predicted increases of 10-32 inches by 2081-2100 (IPCC 2014). These changes will likely result in increased erosion and more frequent and severe coastal flooding, and shifts in the composition of nearshore habitats (Tillmann and Siemann 2011; Reeder et al. 2013). Estuarine-dependent salmonids such as chum and Chinook salmon are predicted to be impacted by significant reductions in rearing habitat in some Pacific Northwest coastal areas (Glick et al. 2007). Historically, warm periods in the coastal Pacific Ocean have coincided with relatively low abundances of salmon and steelhead, while cooler ocean periods have coincided with relatively high abundances, and therefore these species are predicted to fare poorly in warming ocean conditions (Scheuerell and Williams 2005; Zabel et al. 2006). This is supported by the recent observation that anomalously warm sea surface temperatures off the coast of Washington from 2013 to 2016 resulted in poor coho and Chinook salmon body condition for juveniles caught in those waters (NWFSC 2015). Changes to estuarine and coastal conditions, as well as the timing of seasonal shifts in these habitats, have the potential to impact a wide range of listed aquatic species (Tillmann and Siemann 2011; Reeder et al. 2013).

The adaptive ability of these threatened and endangered species is depressed due to reductions in population size, habitat quantity and diversity, and loss of behavioral and genetic variation. Without these natural sources of resilience, systematic changes in local and regional climatic conditions due to anthropogenic global climate change will likely reduce long-term viability and sustainability of populations in many of these Evolutionary Significant Units (ESUs) (NWFSC 2015). New stressors generated by climate change, or existing stressors with effects that have been amplified by climate change, may also have synergistic impacts on species and ecosystems (Doney et al. 2012). These conditions will possibly intensify the climate change stressors inhibiting recovery of ESA-listed species in the future.

The summaries that follow describe the status of the ESA-listed species, and their designated critical habitats, that occur within the action area and are considered in this opinion. More detailed information on the biology, habitat, and conservation status and trend of these listed resources can be found in the listing regulations and critical habitat designations published in the Federal Register (see Table 1) and in the recovery plans and other sources at: https://www.fisheries.noaa.gov/species-directory/threatened-endangered, and are incorporated here by reference.

2.2.1 Status of the Species

For Pacific salmon, steelhead, and certain other species, we commonly use the four "viable salmonid population" criteria (McElhany et al. 2000) to assess the viability of the populations that, together, constitute the species. These four criteria (spatial structure, diversity, abundance, and productivity) encompass the species' "reproduction, numbers, or distribution" as described in 50 CFR 402.02. When these parameters are collectively at appropriate levels, they maintain a population's capacity to adapt to various environmental conditions and allow it to sustain itself in the natural environment.

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

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

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

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

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

Status of LCR Chinook Salmon

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

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

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

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

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

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

Limiting factors. NMFS (2013) identified the following limiting factors for this species:

- Reduced access to spawning and rearing habitat
- Hatchery-related effects
- Harvest-related effects on fall Chinook salmon
- An altered flow regime and Columbia River plume
- Reduced access to off-channel rearing habitat
- Reduced productivity resulting from sediment and nutrient-related changes in the estuary
- Contaminants

Status of LCR Coho Salmon

This species is included in the Lower Columbia River recovery plan (NMFS 2013a). Specific recovery goals are to improve all four viability parameters to the point that the Coast, Cascade, and Gorge strata achieve high probability of persistence. Protection of existing high functioning habitat and restoration of tributary habitat are noted needs, along with reduction of hatchery and harvest impacts. Large improvements are needed in the persistence probability of most populations of this ESU. The recovery plan notes that the Cascade Strata, where the East Fork Lewis River is, "includes the most heavily urbanized areas in the Columbia Basin. Managing the impacts of growth and development on watershed processes and habitat conditions will be key to the protection and improvement of habitat conditions for coho salmon in these areas."

Spatial Structure and Diversity. This ESU includes all naturally spawned populations of coho salmon in the Columbia River and its tributaries in Washington and Oregon, from the mouth of the Columbia River up to and including the Big White Salmon and Hood Rivers, and includes the Willamette River to Willamette Falls, Oregon, as well as multiple artificial propagation programs. Most of the populations in the ESU contain a substantial number of hatchery-origin spawners. Myers et al. (2006) identified three MPGs (Coastal, Cascade, and Gorge), containing a total of 24 DIPs in the Lower Columbia River coho salmon ESU (NWFSC 2015).

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

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

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

- Degraded estuarine and near-shore marine habitat
- Fish passage barriers
- Degraded freshwater habitat: Hatchery-related effects
- Harvest-related effects
- An altered flow regime and Columbia River plume
- Reduced access to off-channel rearing habitat in the lower Columbia River
- Reduced productivity resulting from sediment and nutrient-related changes in the estuary
- Juvenile fish wake strandings
- Contaminants

Status of CR Chum Salmon

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

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

In this ESU there have been a number of large-scale efforts to improve habitat accessibility, one of the primary metrics for spatial structure. On the Hood River, Powerdale Dam was removed in

2010 and while this dam previously provided for fish passage, removal of the dam is thought to eliminate passage delays and injuries. Condit Dam, on the White Salmon River, was removed in 2012 and this provided access to previously inaccessible habitat. Both of these dams were above Bonneville Dam, and at present there are few fish available (122 adults in 2014) to colonize these recently accessible habitats.

Abundance and Productivity. Populations in the Coast Range MPG other than the Grays River DIP exist at very low abundances, intermittently observed in very low numbers (<10) in most tributaries other than the Grays River. Two chum spawning aggregates in the mainstem Columbia River just upstream of the I-205 Bridge are part of the Washougal River aggregate. In November 2013, two adult chum salmon were observed at the North Fork Dam in the Clackamas River. Chum salmon have also been collected at a number of hatcheries and weirs throughout the Cascade Range MPG, but only in very limited numbers (<10). While the absolute numbers of fish present in many populations are critically low, they may represent important reserves of genetic diversity. Within the Gorge MPG, the Lower Gorge population includes chum salmon returning to Hamilton, Hardy, and Duncan Creeks, and the Ives Island area of the mainstem Columbia River below Bonneville Dam. Other mainstem Columbia River spawning aggregations include Multnomah and Horsetail Creeks on the Oregon shoreline, and in the St. Cloud area along the Washington shoreline. The overall trend since 2000 is negative, with the recent peak in abundance (2010-2011) being considerably lower than the previous peak in 2002. The Upper Gorge population is comprised of a small number (105.6±47.7) that migrate past Bonneville Dam to the upper Gorge population area in most years. (Data from http://www.nwp.usace.army.mil/Missions/Environment/Fish/Counts.aspx accessed 4 March 2015).

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

- Degraded estuarine and nearshore marine habitat
- Degraded freshwater habitat
- Degraded stream flow as a result of hydropower and water supply operations
- Reduced water quality
- Current or potential predation
- An altered flow regime and Columbia River plume
- Reduced access to off-channel rearing habitat in the lower Columbia River

Status of LCR Steelhead

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

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

There have been a number of large-scale efforts to improve accessibility (one of the primary metrics for spatial structure) in this DPS. Trap and haul operations were begun on the Lewis River in 2012 for winter-run steelhead, reestablishing access to historically-occupied habitat above Swift Dam. In 2016, 772 adult winter steelhead (integrated program fish) were transported to the upper Lewis River; however, juvenile collection efficiency is at 23.5 percent which is still below target levels of 95 percent. In addition, there have been a number of recovery actions throughout the DPS to remove or improve culverts and other small-scale passage barriers. Many of these actions (including the removal of Condit Dam on the White Salmon River) have occurred too recently to be fully evaluated.

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

Abundance and Productivity. The Winter-run Western Cascade MPG includes native winter-run steelhead in 14 DIPs from the Cowlitz River to the Washougal River. Abundances have remained low but fairly stable, averaging in the hundreds of fish. Notable exceptions to this were the Clackamas and Sandy River winter-run steelhead populations, that are exhibiting recent rises in NOR abundance and maintaining low levels of hatchery-origin steelhead on the spawning grounds (Jacobsen et al. 2014). In the Summer-run Cascade MPG, there are four summer-run steelhead populations. Absolute abundances have been in the hundreds of fish. Long and short term trends for three DIPs (Kalama, East Fork Lewis and Washougal) are positive; though the 2014 surveys indicate a drop in abundance for all three. The Winter-run Gorge MPG has three DIPs. In both the Lower and Upper Gorge population surveys for winter steelhead are very limited. Abundance levels have been low, but relatively stable, in the Hood River. In recent years, spawners from the integrated hatchery program have constituted the majority of the naturally spawning fish. The Wind River and Hood River are the two DIPs in the Summer-run Gorge MPG. Hood River summer-run steelhead have not been monitored since the last status review in 2016. Adult abundance in the Wind River remains stable, but at a low level (hundreds of fish). The overall status of the MPG is uncertain.

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

- Degraded estuarine and nearshore marine habitat

- Degraded freshwater habitat
- Reduced access to spawning and rearing habitat
- Avian and marine mammal predation
- Hatchery-related effects
- An altered flow regime and Columbia River plume
- Reduced access to off-channel rearing habitat in the lower Columbia River
- Reduced productivity resulting from sediment and nutrient-related changes in the estuary
- Juvenile fish wake strandings
- Contaminants

Status of Eulachon

Eulachon were listed as a threatened species on March 18, 2010 (75 FR 13012). NMFS adopted a final recovery plan for eulachon on September 6, 2017 (NMFS 2017). On April 1, 2016, we announced the results of our 5-year review of eulachon status. After completing the review, we recommended the southern DPS of eulachon remain classified as a threatened species.

The major threats to eulachon are impacts of climate change on oceanic and freshwater habitats (species-wide), fishery by-catch (species-wide), dams and water diversions (Klamath and Columbia subpopulations) and predation (species-wide) (NMFS 2017). .

Spatial Structure and Diversity. 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. Core populations for this species include the Fraser River, Columbia River and (historically) the Klamath River. Eulachon leave saltwater to spawn in their natal streams late winter through early summer, and typically spawn at night in the lower reaches of larger rivers fed by snowmelt. After hatching, larvae are carried downstream and widely dispersed by estuarine and ocean currents. Eulachon movements in the ocean are poorly known, although the amount of eulachon bycatch in the pink shrimp fishery seems to indicate that the distribution of these organisms overlap in the ocean. The southern DPS includes four major subpopulations: Columbia, Klamath, Frazier, and British Columbia. However, these subpopulations do not include all spawning aggregations within the DPS. For instance, spawning runs of eulachon have been noted in Redwood Creek and the Mad River in California, the Umpqua River and Tenmile Creek in Oregon, and the Naselle and Quinault rivers in Washington (NMFS 2017).

Abundance and Productivity. In the early 1990s, there was an abrupt decline in the abundance of eulachon returning to the Columbia River with no evidence of returning to their former population levels since then (Drake et al. 2008). Persistent low returns and landings of eulachon in the Columbia River from 1993-2000 prompted the states of Oregon and Washington to adopt a Joint State Eulachon Management Plan in 2001 that provides for restricted harvest management when parental run strength, juvenile production, and ocean productivity forecast a poor return (WDFW and ODFW 2001). Despite a brief period of improved returns in 2001-2003, the returns and associated commercial landings have again declined to the very low levels observed in the mid-1990s (Joint Columbia River Management Staff 2009). Starting in 2005, the fishery has operated at the most conservative level allowed in the management plan 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. Therefore, it is too early to tell whether recent improvements in the southern DPS of eulachon will persist or whether a return to the severely depressed abundance years of the mid-late 1990s and late 2000s will recur (NMFS 2017).

Limiting Factors. Limiting factors for this species include (NMFS 2017):

- 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).

Salmon and Steelhead. For salmon and steelhead, NMFS ranked watersheds within designated critical habitat at the scale of the fifth-field hydrologic unit code (HUC_5) in terms of the conservation value they provide to each listed species they support.[4] The conservation rankings are high, medium, or low. To determine the conservation value of each watershed to species viability, NMFS's critical habitat analytical review teams (CHARTs) evaluated the quantity and quality of habitat features (for example, spawning gravels, wood and water condition, side channels), the relationship of the area compared to other areas within the species' range, and the significance to the species of the population occupying that area (NOAA Fisheries 2005). Thus, even a location that has poor quality of habitat could be ranked with a high conservation value if it were essential due to factors such as limited availability (e.g., one of a very few spawning areas), a unique contribution of the population it served (e.g., a population at the extreme end of geographic distribution), or if it serves another important role (e.g., obligate area for migration to upstream spawning areas).

[4] The conservation value of a site depends upon "(1) the importance of the populations associated with a site to the ESU [or DPS] conservation, and (2) the contribution of that site to the conservation of the population through demonstrated or potential productivity of the area" (NOAA Fisheries 2005).

The PBFs of salmonid critical habitat include: (1) Freshwater spawning sites with water quantity and quality conditions and substrate supporting spawning, incubation and larval development; (2) Freshwater rearing sites with: (i) Water quantity and floodplain connectivity to form and maintain physical habitat conditions and support juvenile growth and mobility; (ii) Water quality and forage supporting juvenile development; and (iii) Natural cover such as shade, submerged and overhanging large wood, log jams and beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks; (3) Freshwater migration corridors free of obstruction and excessive predation with 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 supporting juvenile and adult mobility and survival; (4) Estuarine areas free of obstruction and excessive predation with: (i) Water quality, water quantity, and salinity conditions supporting juvenile and adult physiological transitions between fresh- and saltwater; (ii) Natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels; and (iii) Juvenile and adult forage, including aquatic invertebrates and fishes, supporting growth and maturation; (5) Nearshore marine areas free of obstruction and excessive predation with: (i) Water quality and quantity conditions and forage, including aquatic invertebrates and fishes, supporting growth and maturation; and (ii) Natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, and side channels; and (6) Offshore marine areas with water quality conditions and forage, including aquatic invertebrates and fishes, supporting growth and maturation. The PBFs are listed in Table 2.

Table 2. Physical or biological features and corresponding life history events of designated critical habitat for Lower Columbia River salmon and steelhead. Although nearshore and offshore marine areas were identified in the FRs, no nearshore or offshore marine areas were designated as critical habitat for LCR salmon or steelhead and are not included in the table.

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

CHART Salmon and Steelhead Critical Habitat Assessments

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

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

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

<u>Southern DPS Eulachon</u>. Critical habitat for eulachon includes portions of 16 rivers and streams in California, Oregon, and Washington (USDC 2011). All of these areas are designated as migration and spawning habitat for this species. In Oregon, 24.2 miles of the lower Umpqua River, 12.4 miles of the lower Sandy River, and 0.2 miles of Tenmile Creek have been designated. The mainstem Columbia River from the mouth to the base of Bonneville Dam, a distance of 143.2 miles is also designated as critical habitat.

The PBF's of eulachon critical habitat include: (1) Freshwater spawning and incubation sites with water flow, quality and temperature conditions and suitable substrate for spawning and incubation, as well as migratory access for adults and juveniles. These features are essential to conservation because without them the species cannot successfully spawn and produce offspring. (2) Freshwater and estuarine migration corridors associated with spawning and incubation sites that are free of obstruction and with water flow, quality and temperature conditions supporting larval and adult mobility, and with abundant prey items supporting larval feeding after the yolk sac is depleted. These features are essential to conservation because they allow adult fish to swim upstream to reach spawning areas and they allow larval fish to proceed downstream and reach the ocean. (3) Nearshore and offshore marine foraging habitat with water quality and available prey, supporting juveniles and adult survival. These features are essential to conservation because they allow juvenile fish to survive, grow, and reach maturity, and they allow adult fish to survive and return to freshwater systems to spawn. Table 3 identifies the PBFs for eulachon.

Table 3. Physical or biological features of critical habitats designated for eulachon and corresponding species life history events. Although nearshore and offshore marine foraging was identified in the FR, "specific areas" where either component of the essential features is found within marine areas believed to be occupied by eulachon were not identified and is not included in the table.

Physical or biological features Site Type	**Physical or biological features Site Attribute**	**Species Life History Event**
Freshwater spawning and incubation	Flow Water quality Water temperature Substrate	Adult spawning Incubation
Freshwater and estuarine migration corridors associated with spawning and incubation sites	Migratory corridor Flow Water quality Water temperature Food	Adult and larval mobility Larval feeding

The range of eulachon in the Pacific Northwest completely overlaps with the range of several ESA-listed stocks of salmon and steelhead as well as green sturgeon. Although the habitat requirements of these fishes differ somewhat from eulachon, efforts to protect habitat generally focus on the maintenance of watershed processes that would be expected to benefit eulachon. The BRT identified dams and water diversions as 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 systems, large-scale impoundment of water has increased winter water temperatures, potentially altering the water temperature during eulachon spawning periods (Gustafson et al. 2010). Numerous chemical contaminants are also present in spawning rivers, but the exact effect these compounds have on spawning and egg development is unknown (Gustafson et al. 2010). The BRT identified dredging as a low to moderate threat to eulachon in the Columbia River. Dredging during eulachon spawning would be particularly detrimental. The lower Columbia River mainstem provides spawning and incubation sites, and a large migratory corridor to spawning areas in the tributaries. Prior to the construction of Bonneville Dam, eulachon ascended the Columbia River as far as Hood River, Oregon. Major tributaries that support spawning runs include the Grays, Skamokawa, Elochoman, Kalama, Lewis and Sandy rivers.

The number of eulachon returning to the Umpqua River seems to have declined in the 1980s, and does not appear to have rebounded to previous levels. Additionally, eulachon are regularly caught in salmonid smolt traps operated in the lower reaches of Tenmile Creek by the Oregon Department of Fish and Wildlife (ODFW).

Willamette-Lower Columbia Recovery Domain. Critical habitat was designated in the Willamette-Lower Columbia (WLC) recovery domain for LCR Chinook salmon, LCR steelhead, CR chum salmon, LCR coho salmon, and eulachon.

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

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

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

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

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

The CHART for the WLC recovery domain determined that most HUC_5 watersheds with PBFs for salmon or steelhead 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. Only watersheds in the upper McKenzie River and its tributaries are in good to excellent condition with no potential for improvement. The lower Lewis River current PBF broadly range from poor to excellent but the restoration potential is poor to good.

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).

<u>Environmental conditions at the project site and the surrounding area:</u>

The Lewis River is a tributary to the Columbia River that drains at RM 87. The East Fork Lewis River watershed occupies approximately 212 square miles (Cramer and Associates 2005), and lies almost entirely within Clark County. The East Fork Lewis River flows west from the headwaters on the western slope of Lookout Mountain in Skamania County, and enters the mainstem of the Lewis (also referred to as the North Fork) at approximately RM 3.5, approximately 4,000 feet downstream of the I-5 Bridge. The lower 12 miles of the mainstem and East Fork flow through a wide flat valley, much of which is developed with agricultural or residential areas. Within this area, sediments are generally composed of sand, silts, and clays.

The project and action areas are tidally influenced and navigable. Tidal portions extend to RM 5.7 (Mason Creek) but are entirely freshwater. The East Fork Lewis River is navigable up to the La Center Bridge at RM 3. The gradient is near zero from RM 5.7 to the mouth; flows are sluggish (Ecology 2009; Cramer and Associates 2005). Lucia Falls (RM 21) blocks most passage of anadromous fish except steelhead and an occasional Chinook or coho. Upstream migration for steelhead was blocked at Sunset Falls (RM 32) until 1982 when the falls were notched, allowing approximately 12 percent of the returning steelhead access above the falls to spawn. There are no artificial barriers in the East Fork Lewis River.

Most of the project area is located within and adjacent to Paradise Point State Park outside of the city of La Center, Washington. The East Fork Lewis River runs east to west under the existing bridge. Within the action area, the width of the East Fork Lewis River ranges from approximately 150 feet to 250 feet wide in a single confined channel. The south side of the river is dominated by cultivated grass from the state park with a 70-100 foot wide strip of riparian vegetation. In the project area on the north side, there is very little development with a 200-300 foot wide riparian zone.

The river channel is a sand and gravel bottom with well vegetated banks up and downstream. Due to the shallow and wide nature of the project reach, the center of the river is exposed to direct sunlight regardless of vegetated banks. Under the bridge, the south bank is a sand bar and the north bank is rock with a barb on the east side. At lower flows, the sandbar exposure is more widespread, extending out to near mid-river. Significant recreational activities (swimming, kayak, and canoeing) occur on the south side "beach" during the summer months. The dominant shoreline habitat on the north side is a near-vertical rock face that extends to just below the OHWM. The vertical clearance between the existing bridge and the OHWM is approximately 35.2 feet on the north bank and 33.4 feet on the south bank. The maximum water depth in the vicinity of the bridge is approximately 20 feet deep.

The project area provides very limited woody material and there are no pool or riffle habitats. Spawning only occurs upstream due to a lack of gravel and cobble substrates, which also diminishes juvenile rearing habitat values. The floodplain and off-channel habitat connectivity has been significantly reduced due to extensive diking.

The East Fork Lewis River and its tributaries are listed on the state's polluted waters list (303d list) for warm water temperatures and fecal coliform bacteria problems. Recent data has found high surface water temperatures during summer periods within the East Fork Lewis River, further limiting the year-round potential presence of juveniles. Mining and other activities have added sediment to the river. Sedimentation has caused the East Fork to become wider and shallower, which in turn leads to higher water temperatures. In 2016 and 2018, WDFW collected summertime temperatures downstream of the site near the confluence of the East Fork and mainstem (approximately 0.7 mile downstream of the project area). Temperatures were highly variable in tidally influenced areas, ranging from 58º F to 80º F (Wadsworth 2019), restricting the rearing habitat quality in the project portion of the river, especially in the summer months. The upper portion of the East Fork's watershed has the lowest water temperatures, and temperatures tend to get higher in the river's lower watershed.

Fecal coliform levels increased from 2005 to 2016, although concentrations in the East Fork generally were within water quality standards, with the exception of part of the river's lower watershed (Ecology 2018). Fecal coliform bacteria is from human or animal waste entering the East Fork's watershed. Potential sources include failing septic systems and excrement from wildlife, livestock and domestic dogs and cats. Storm runoff can pick up these contaminants and carry them to the river.

Baseline metal concentrations within the East Fork basin are relatively low, based on data collected by Clark County Public Works. Mean dissolved copper (0.57 μg/L) and zinc (2.3 μg/L) data were collected between 2012 and 2019 approximately 1.75 miles and 5.7 miles upstream of the project area (Schnabel, unpublished data, 2019).

In 2016, WSDOT counts of average annual daily traffic volumes on I-5 in the action area were approximately 82,000, which likely equates to approximately 8,500 vehicles per hour in the daytime, which in turn equates to a noise level of approximately 81 dBA L_{max} for traffic moving at the posted speed limit of 70 miles per hour. A complete description of the environmental baseline is located in Section 4.0 of the BA (FHWA 2020, pp. 33-40).

The condition of the listed species and critical habitat in the action area is described for each species below.

LCR Chinook within the Action Area:

Fall Chinook enter the Lewis River from August to November, depending on the timing of initial fall rains. Natural spawning in the East Fork Lewis River occurs in two distinct segments: the early segment in October (fall Chinook) and the late segment from November through January (late fall Chinook). Fry emerge from March to August (peak usually in April) depending on time of egg deposition and water temperature. Fall Chinook fry spend the spring in fresh water and emigrate in the summer as sub-yearlings. Spawning in the East Fork Lewis River occurs primarily within a 6 mile reach from Lewisville Park to Daybreak Feeders. Suitable spawning gravels are not present in the action area.

Fall Chinook escapement estimates by WDFW in 1951 were about 4,000 into the East Fork Lewis River, and averaged 279 from 1986 through 2001. The Multi Species Status Assessment in the Columbia River (McClure et al. 2003) indicated a zero risk of extinction in 50 years for East Fork Lewis River fall Chinook, although the recovery plan identifies Lewis River fall Chinook as having a very low probability of persistence (NMFS 2013a). According to the Native Fish Society (2016), the EF Lewis early and late components of natural produced fall chinook have been sustained at low levels with minimal influence from hatchery fish. Late fall Lewis River Chinook are identified as having a very high probability of persistence. Fall and late fall are both considered primary populations for recovery. The recovery strategy places a high priority on improving juvenile rearing habitats in tributaries be recreating stream habitat complexity, and reducing the impacts of sediment (NMFS 2013a).

Lewis River spring Chinook spawned throughout the upper watershed, but with the construction of Merwin Dam at RM 19.2, the majority of the spawning grounds became naturally inaccessible. Still, the Lewis River (North Fork) is one of the top Springer rivers in Washington State. Today, natural spawning is observed in the East Fork Lewis River, in very low numbers, and is composed primarily of hatchery strays (HSRG 2009). Peak entry occurs in April, and spawning generally occurs from late August through early October. Spring Chinook salmon are “stream-type” salmon that generally rear in the river for a full year. Most stream-type juveniles emigrate from fresh water as yearlings, typically in the spring of their second year. However, some juveniles from Lower Columbia River spring Chinook salmon populations migrate downstream from their natal tributaries in the fall and early winter into larger rivers, including the mainstem Columbia River, where they are believed to over-winter before outmigrating the next spring as yearling smolts (NMFS 2013a).

There is no abundance and productivity or recovery data for spring Chinook in the East Fork Lewis River subbasin, which is focused on fall Chinook (NMFS 2013a). Spring Chinook used to outnumber fall Chinook in Columbia River catches 2 to 1, but this is no longer the case. Because their fry spend a long time living in streams, spring Chinook have been especially hard-hit by pollution and siltation of stream habitat

LCR Coho within the Action Area: Both early (Type S) and late (Type N) coho spawn in the East Fork Lewis River. Coho historically spawned throughout the basin, and natural spawning is thought to occur in most areas accessible to coho. On the East Fork, spawning occurs primarily below Lucia Falls (RM 21); Lockwood, Mason, and Rock Creeks are extensively used.

Adults enter the Columbia River from August through January (early stock primarily from mid-August through September and late stock primarily from late September through November). Peak spawning occurs in late October for early stock and December to early January for late stock. Coho fry emerge in the spring and spend one year in fresh water, outmigrating in the following spring.

Lewis River wild coho run is a fraction of its historical size, and natural coho production is presumed to be generally low in most tributaries. Hatchery production accounts for most coho returning to the Lewis River (Native Fish Society 2016). The recovery plan indicates that the probability of persistence of East Fork Lewis River coho is very low but the recovery goal for this "primary population" is restore it to high probability of persistence, with tributary restoration goals to increase of-channel, side-channel, and floodplain habitat, and improve riparian cover for over winter habitat (NMFS 2013a).

No coho spawning occurs in the action area. After hatching, juvenile coho salmon rear for a year in the East Fork Lewis River and outmigrate by June. Because they overwinter in the East Fork Lewis River, juvenile coho salmon are present year-round.

<u>CR Chum within the Action Area:</u> The East Fork Lewis River within the action area is documented to support Columbia River chum salmon (Wadsworth 2019), and spawning can occur in the lower reach of the East Fork Lewis River (Native Fish Society 2016). Columbia River chum salmon run from mid-October through November; peak spawner abundance occurs in late November. Fry emerge in early spring, generally from March to mid-May.

The entire Lewis River chum salmon population is very low, likely less than 100 individuals. Historical abundance was more than 100,000 fish; the current target goal is 1,300 (Wadsworth 2019). Annually, 3-4 adult chum are captured at the Merwin Dam fish trap in the Lewis River (North Fork). The probability of persistence of Lewis River chum is very low, however the target status for recovery is to return thus primary population to a high level of persistence, by protecting and restoring tributary habitats, including the creation of chum salmon spawning channels as a priority short-term action.

It is unknown where in the East Fork Lewis River chum spawning occurs, but suitable riffle habitats with spawning gravels are approximately 7 miles upstream of the proposed action. Adult migrations through the project area may occur in October, during the general in-water work period but outside of the WSDOT impact pile driving work window (July 1-September 30).

<u>LCR Steelhead within the Action Area:</u> The East Fork Lewis River supports summer and winter run steelhead. Spawning occurs in the East Fork Lewis River, as well as Rock Creek and other tributaries; rearing habitat is available throughout most of the basin. Adult migration timing for East Fork Lewis River summer steelhead is from May through November. Adult migration timing for East Fork Lewis River winter steelhead is from December through April. For both, spawning timing is generally from early March through early June. Wild steelhead fry emerge from late April through July; juveniles generally rear in fresh water for 2 years; juvenile emigration occurs from March to May, with peak migration in early May.

Average wild summer steelhead escapement to the East Fork Lewis River from 1991-1996 was 851. Surveys in 2014 found a drop in abundance for East Fork Lewis River summer steelhead (NWFSC 2015).The escapement goal for the East Fork Lewis River is 814 wild adults. Wild fish production is believed to be moderate; the portion of wild summer steelhead in the run at Lucia Falls averaged 27 percent from 1974-1983. Recent snorkel surveys indicate hatchery summer steelhead comprise about 70% of the spawning escapement on the East Fork Lewis River.

Redd index escapement counts for winter steelhead from 1986-2001 produced an average of 157 fish. The escapement goal for the East Fork Lewis River is 875 wild adult steelhead. Recent data suggests that 51% of spawning winter steelhead in the East Fork are of hatchery origin (Native Fish Society 2016). The Multi Species Status Assessment in the Columbia River (McClure et al. 2003) predicted a risk of 1.0 for the risk of 90% decline for the East Fork Lewis River winter steelhead in both 25 and 50 years. Winter steelhead natural production is unknown. Abundances were low but considered stable during the status update of 2015 (NWFSC 2015).

The East Fork Lewis River steelhead winter and summer steelhead populations are both considered primary populations for recovery. Winter steelhead is identified as having a moderate probability of persistence, with a recovery objective high probability of persistence. EFRL summer steelhead are at very low probability of persistence with a target of achieving high probability. For both populations, particularly in the East Fork Lewis, recovery is expected to require restoring lowland floodplain function, riparian function, and stream habitat diversity.

Steelhead spawning also does not occur in the action area due to a lack of gravel substrates but is documented spawning upstream. Rearing juvenile steelhead may spend multiple years in the river and could occur in the action area at any time of year.

<u>Eulachon within the Action Area:</u> The Columbia River and its tributaries are believed to support the largest eulachon run in the world (Gustafson et al. 2016). Pacific eulachon are tributary spawners within the lower Columbia River, and utilize the main-stem Columbia River for adult migration, and drift of eggs and larvae to the estuary. Adult eulachon ascend large tributaries of the CR such as the Cowlitz, Elochoman, Grays, Kalama, Lewis, Sandy, and others during late winter and spring; Adult eulachon may return as early as late November, but typically this occurs during January through March, and continues through May (Howell et al 2001). Eggs adhere to the surface of the substrate, consisting of coarse sand and fine gravel, and incubate over a period of 30 to 40 days. Eggs and larvae are present until early June, as they drift in currents downstream to the Columbia River estuary.

During daylight the adults are bottom-oriented (NPCC 2015). They typically spawn at night in the lower reaches of larger rivers fed by snowmelt when water temperatures are 4^{o} to 10^{o} Celsius. Spawning often occurs in the stream reach of tidal influence.

Beginning in 2010, ODFW and WDFW began eulachon biomass surveys similar to those conducted in the Columbia River. Based on the two years of data that have been collected and analyzed, WDFW calculated a median spawner estimate of approximately 40 million eulachon in 2011 and 39 million in 2012 (James et al 2014). WDFW estimates the Chehalis River produces 11 metric tons. An estimated 11.2 eulachon per pound equated to approximately 272,000 adult spawners (Gustafson et al 2016). NMFS estimates an annual average of 590,000,000,000 larvae hatch in the Columbia River (NMFS 2015a). There are no known productivity records for the East Fork Lewis River.

Eulachon spawning has been documented in the Lewis River up to the Lake Merwin Dam from November to April (Cowlitz Indian Tribe 2013). Larval eulachon have been found in the East Fork Lewis River up to the confluence with Mason Creek, 5.7 miles from the confluence with the mainstem (50 CFR Part 226). The capture of larval eulachon in the East Fork Lewis River indicates that these areas contain the habitat suitable for spawning and incubation, and a migration corridor. Eulachon spawning has been documented upstream of the action area and sampling has found that eulachon larvae are present within the Lewis River Basin in April and May.

Salmon and Steelhead Critical Habitat within the Action Area: In the 2005 critical habitat assessment report NOAA Fisheries 2005) , the East Fork Lewis River watershed is identified as supporting historically independent populations of ESA-listed Chinook salmon, chum salmon, and steelhead. The rankings for "current quality" of the PCE's in the watershed is fair to poor for all three species. However, there is high potential for restoration for Chinook and steelhead, and some potential for restoration for chum. The conservation value of the East Fork Lewis watershed is ranked as high because of the important role the area serves as migration for adults to spawning areas and juveniles to the ocean. The East Fork is noted as some of the best remaining habitat supporting Lewis River Chinook, and as having seeps or springs that may be important for chum. Additionally, the improved access above Sunset Falls likely makes PCEs for steelhead more extensive now than historically.

In the final biological report (NMFS 2015b), critical habitat PCEs for ESA-listed coho in the East Fork Lewis River support a population that is expected to play a primary role in recovery with a high level of viability. In addition to the recovery planning emphasis in this HUC_5, the East Fork Lewis River is the only major undammed stream within the Washington side of the Columbia River basin, and has a high conservation value ranking. The ranking for "current quality" of the PCE's in the watershed for coho is fair to good condition, and there is some potential for restoration.

Critical habitat for LCR Chinook, LCR coho, CR chum, and LCR steelhead has been designated in the East Fork Lewis River. The PCE's present within the action area include freshwater rearing and migration corridors. Spawning for each species has been documented or suitable spawning habitat is present upstream of the action area. There are no man made barriers on the EFL and there are sufficient migration corridors without impediments. Adult salmonids travel up the river to spawn, and juveniles move downstream through the action area. Due to a lack of thermal refugia and large woody material, quality rearing habitat is lacking in the action area, and most rearing is believed to take place upstream.

<u>Eulachon Critical Habitat within the Action Area:</u> Critical habitat for eulachon has been designated in the East Fork Lewis River. The capture of larval eulachon in the East Fork indicates that it contains the spawning and incubation, and migration corridor essential features. Eulachon habitat and habitat use varies widely among the areas used, and may vary within the

same area across different years. The loss of any one of the areas used by eulachon could potentially leave a large gap in the spawning distribution of the DPS, and the loss to eulachon production could represent a significant impact on the ability of the southern DPS to survive and recover. Therefore, all of the specific areas used, including the East Fork Lewis River, have a high conservation value and are considered essential to the recovery of the southern DPS of eulachon (NMFS 2011b).

The PBFs present include freshwater spawning and incubation, and freshwater migration. Both the substrate condition and flow regime are suitable for eulachon spawning, based on the presence of larvae documented throughout the action area (Cowlitz Indian Tribe 2013; 50 CFR 226). Eulachon spawning has been documented upstream of the action area. There are no man made barriers on the EFL and there are sufficient migration corridors. Adult eulachon travel up the river to spawn, and larval eulachon move downstream through the action area.

Climate Change: Climate change has affected the environmental baseline of aquatic habitats across the region and within the action area. The combined effects of increasing air temperatures and decreasing spring through fall flows are expected to cause increasing stream temperatures; in 2015 this resulted in 3.5-5.3°C increases in Columbia Basin streams (NWFSC 2015). Higher temperatures will reduce the quality of available salmonid habitat for most freshwater life stages where reduced flows will limit their access to available habitat (Mantua et al. 2010; Isaak et al. 2012), and are likely to cause several species to become more susceptible to parasites, disease, and higher predation rates (Crozier et al. 2008; Wainwright & Weitkamp 2013; Raymondi et al. 2013).

Climate change is expected to produce flashier flows within the East Fork Lewis drainage, trigger severe storm events, cause warmer and drier summers, and increase water temperatures, thereby negatively affecting fish habitat. The adaptive ability of these threatened species in the Lower Columbia River system is depressed due to reductions in population size, habitat quantity and diversity, and loss of behavioral and genetic variation. Without these natural sources of resilience, systematic changes in local and regional climatic conditions due to anthropogenic global climate change will likely reduce long-term viability and sustainability of populations in many of the Columbia River ESUs/DPS (NWFSC 2015). New stressors generated by climate change, or existing stressors with effects that have been amplified by climate change, may also have synergistic impacts on species and ecosystems (Doney et al. 2012). These conditions will possibly intensify the climate change stressors inhibiting recovery of Columbia River ESA-listed species in the future.

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. A consequence is caused by the proposed action if it would not occur but for the proposed action and it is reasonably certain to occur. Effects of the action may occur later in time and may include consequences occurring outside the immediate area involved in the action (see 50 CFR 402.17). In our analysis, which describes the effects of the proposed action, we considered 50 CFR 402.17(a) and (b).

The effects of the proposed action are expected to occur during construction in the water and have delayed and on-going consequences due to stormwater runoff. Effects from in-water construction are temporary, occurring during the authorized in-water work window, from July 1 through October 31, each year for 4 years. Additionally, the FHWA/WSDOT builds bridges to ensure a minimum structure service life of 75 years is provided (WSDOT 2020). As such, NMFS determined the proposed action covers a 75-year period.

All of the species discussed in this opinion have been documented within the Lewis River Basin. Each species migrates, spawns, and rears within the East Fork Lewis River, and, due to the lack of spawning gravels in the action area, all salmonid spawning areas are upstream. Due to construction timing, in-water work during peak upstream migration of adults and peak outmigration of salmonid juveniles and larval eulachon will be avoided. Still, the following have the potential to be exposed to the effects of construction in low numbers: 1) early returning adults and late outmigrating juvenile LCR Chinook salmon, 2) late returning adults and rearing juvenile LCR coho salmon, 3) returning adult CR chum salmon, and 4) late summer returning adults and rearing juvenile LCR steelhead. The habitat features common to salmonid rearing and migration habitats are water quality, water quantity, and natural cover. Benthic communities and riparian cover are also common to salmonid rearing and migration areas. Substrate is a feature primarily associated with spawning. As with the listed salmonids, eulachon spawn upstream of the project action area. The action area only supports freshwater migration habitat for adult eulachon and drifting larvae.

All life histories of the four salmonid species and eulachon will be exposed to the ongoing effect resulting from stormwater runoff.

Effects of the proposed action which are reasonably certain to occur include: 1) fish handling and elevated noise, 2) reductions in water quality, and 3) habitat modification, and reduced access to habitat. The magnitude of these effects will vary temporally, and are discussed in turn below.

2.4.1 Effects on Critical Habitat

The proposed action, including full application of the planned conservation measures and BMPs, is likely to adversely affect designated critical habitat for LCR Chinook salmon, LCR coho, CR chum, LCR steelhead and southern DPS eulachon.

The action area includes the freshwater rearing, and migration corridor PBFs for salmonids. The PBFs present for eulachon include freshwater spawning and incubation, and freshwater migration. Features common to critical habitat for each salmonid species and eulachon are water quality, substrate, and migration corridors. Natural cover and floodplain connectivity are PBFs only for salmonids in the action area. Prey is also a PBF only for salmonids only in the action area, as larval eulachon absorb their yolk sacs for nutrition while in their passive migration life stage. The expected effects would be on essential features of freshwater only, as there are no estuarine or marine habitats within the action area.

Water Quality

The proposed action would cause short-term adverse impacts on water quality during construction. In-water work in the East Fork Lewis River will occur between July 1 and October 31 and generate temporary elevated turbidity.

The proposed action would also cause long term effects on water quality. Traffic volumes are not expected to change dramatically, but may slowly increase with population growth over time. No method of treatment other than full infiltration will fully remove all contaminants from road runoff. Contaminants in road runoff are dominated by vehicle sources including break friction materials and tire wear. Stormwater generated from the new PGIS will contribute runoff with contaminants that include total suspended solids (TSS), and dissolved copper (DCu) and dissolved zinc (DZn).

It is not feasible to achieve 100% infiltration at this site because of space limitations. Regardless of the alignment selected, all of the new PGIS will be biofiltrated to remove the majority of TSS, including tire particles, as well as DCu and DZn. Linear roadside stormwater treatment facilities in the form compost-amended biofiltration swales or compost-amended vegetated filter strips will be constructed within the existing right-of-way. These facilities are considered enhanced water quality treatment because with compost, they are expected to provide at least 60% infiltration. Recent studies have confirmed that bioretention of runoff is effective at removing dissolved metals and TSS, as well as PAHs from exhaust and many other contaminants (McIntyre et al. 2016). Post bio-retention, stormwater discharges from the proposed action will be directed into the East Fork Lewis River, but this section of the river does not contain spawning habitat or high-quality rearing habitat, as described in Section 2.3, which is located upstream of the proposed action. Due to a lack of habitat features and high water temperatures, the results of recent juvenile salmonid seining in the Lower Lewis River have determined that salmonid smolts spend very little time (on the order of a few days) in the lower reaches before they emigrate to the Columbia River (NMFS 2015c).

Dilution modeling[5] identifies the distance from the discharge point where it becomes impossible to discern the additional levels of pollutants from the background level. However, this does not mean that the receiving water bodies or downstream waters are not impaired by this additional source of contaminants, but rather that the additional load can no longer be meaningfully measured based on their aqueous limits of detection. In the case of the proposed action, under the worst-case scenario, the probability that stormwater treatment BMPs reduce the overall pollutant load into the watershed from current levels is high enough to indicate a potential for adverse effects to fish and their prey. Also, while the long-term, post-project stormwater conditions in fish-bearing waters within the action area show modeled improvements over the existing concentrations for TSS, there is a slight increase for DCu and DZn (FHWA 2020, Appendix D).

Under the scenario with more new PGIS, there will be more enhanced treatment of runoff prior to discharge into the East Fork. This suggests that if the new alignment is chosen, the stormwater

[5] Pollutant loads, concentrations and distance to dilute to background levels were analyzed using the HI-RUN program approved by WSDOT, FHWA, NMFS, and USFWS per the 2009 Memorandum of Agreement (FHWA et al. 2009). https://www.wsdot.wa.gov/environment/technical/fish-wildlife/policies-and-procedures/esa-ba/stormwater-guidance

treatment BMPs will reduce the overall pollutant load into the watershed from current levels. While this scenario improves water quality associated with road run off, it does not eliminate contaminants from reaching fish-bearing waters. Of the two choices, this scenario provides more stormwater treatment and, if selected, is expected to provide sufficient treatment prior to discharge that harmful biological thresholds for DCu and DZn are not exceeded when the stormwater enters the river.

Potential zones within which post-treatment stormwater pollutants would exceed biological thresholds for harm (DZn = 5.4 µg/L and DCu = 2 µg/L) in the East Fork Lewis River is small under all modeled conditions (less than 12 inches in all months and range of depths, including summer low flow conditions). These results indicate no change to the baseline stormwater dilution conditions from the proposed action for DCu and DZn (FHWA 2020, Table 19). That said, other stormwater contaminants including tire wear particles and PAHs likely degrade habitat and affect exposed salmonids.

Water quality as a PBF of migration habitat will be slightly degraded for each of the five species. The water quality reduction also slightly diminishes its value as a PBF of rearing habitat for Chinook salmon, coho, and steelhead.

Corridors Free from Obstruction

Pile driving creates noise in the aquatic environment that can function as an obstacle in migration corridors. Pile driving duration is often times overestimated because it includes the time to set the pile in the proper location, and it is these activities that limit the number of piles that can be successfully installed per day. According to measurements collected in the field during marine mammal monitoring efforts, WSDOT has determined that the actual time spent with the hammer in operation is much less than the installation estimates provided by engineering staff. Based on data collected during the US 101 Chehalis River Bridge repair in 2019, the actual time the vibratory pile driving hammer is expected to be in operation is less than 5 minutes per pile[6]. Impact pile driving is estimated to occur at a rate of 40 strikes per minute. FHWA will impact drive up to 3 piles per day (300 strikes max each) for a maximum of 900 strikes per day. The total time of impact driving per day (in the water) is estimated at under an hour per day (approximately 23 minutes at a rate of 40 strikes per minute) of actual striking. There will be a 12-hour overnight rest period each day. A bubble curtain or other sound attenuation device that has been designed to meet approved specifications will be used to reduce underwater sound pressure levels (SPLs).

Due to natural bends in the river, the maximum extent of underwater noise from pile driving is estimated at 0.25 mile upstream and 0.25 miles downstream for 0.5 mile. Sound that will extend this linear distance will also span across the width of the river, creating a complete blockage to fish periodically for short periods of time each day. Pile driving will not preclude salmonid movement through the area during construction as fish will still be able to migrate through the action area between periods of pile driving, and at night (specifically steelhead and coho juveniles).

[6] Based on email communication with Jeff Dreier, WSDOT Fish and Wildlife Manager who provided results from the U.S. 101/Chehalis River Bridge Scour Repair Project Marine Mammal Monitoring Report (September 2019).

The piles to be installed that support temporary structures also have the potential to create obstructions within the migration corridor for fish. The piles will be spaced at sufficient distance that flows will not be restricted, and, as required by the USCG, there is a minimum horizontal clearance required for navigation purposes. Thus, the temporary structures will not measurably change available space or movement of water, are considered insignificant modifications to migration corridors.

Shade from structures can cast a sharp light/dark contrast that can impair the migration corridor for juvenile salmonids and disrupt other habitat function (Carrasquero 2001). Temporary over water structures will shade a maximum of 15,500 ft^2 of the river; 6,500 ft^2 from platforms and if needed, the temporary bridge will create 9,000 $feet^2$ of shade over the East Fork Lewis River, and would remain through most of the construction. The shade from the existing bridge will essentially be replaced by the new bridge, but will be at a higher elevation above OHW. Therefore, the permanent replacement structure will not measurably increase the existing shaded area; a portion of the river shaded by temporary platforms (approximately 500 ft^2) will be replaced by shade from the new bridge. Site specific factors such as water clarity and depth in concert with the type and use of the structure determine the magnitude of this effect. The WSDOT has data suggesting that bridges higher than 24 feet do not affect vegetation growth (WSDOT 2009). There is no aquatic vegetation in the action area, but riparian vegetation currently grows beneath the existing bridges, indicating that there is light penetration. The majority of the temporary (9,000 ft^2) and all permanent sources of shade are high enough (25 feet or more) above the water surface that indirect light conditions can predominate and mute the light/dark contrast in most weather conditions.

Because passage is obstructed by noise during the work window only, and even within that timeframe is not continuous but is interrupted by breaks in work, migration values of critical habitat for all 5 species are only slightly diminished. The presence of temporary and permanent piles do not present significant obstruction to movement in the migration corridor for any of the 5 species. Finally, the shade cast by the replacement bridge and by the temporary structures are not expected to create a stark light/dark contrast that interferes with juvenile salmonid migration in most circumstances. We consider the migration value for salmonid critical habitat to be largely retained. For eulachon eggs and larvae, passage is passive, and we do not anticipate any detriment to passage values for this species' critical habitat.

Benthic Prey Communities/Substrate

The installation of up to 150 temporary 30-inch diameter steel piles will displace a maximum of 810 ft^2 of benthic habitat and has the potential to diminish the density and diversity of the benthic community at the project site. Also, cofferdams will isolate a maximum of 20,000 ft^2 of the East Fork Lewis River below the OHWM and will be left in place over two winters, making this area inaccessible to juvenile salmonids for foraging.

Loss of benthic habitat will slightly, but temporarily, reduce invertebrate production, decreasing the availability of salmonid prey. Although the temporary piles could be in place over 3 years, because prey is not considered limiting in the action area, we consider the reduction, even over three years, too small to impair this PBF. Also, the disturbed benthic organisms would likely recover their former level of abundance and diversity very quickly after the project is complete, typically within two months if upstream prey communities are present to recolonize the area. The piles or drilled shafts that will be used for the permanent bridge are not expected to affect the benthic community or availability of prey because the areas they will occupy are only periodically submerged. Grounding of the work barge(s) may displace the benthic community over a small but unknown area, and would be of short duration. Shade, and potential grounding of the barge during construction will not occur in areas of aquatic vegetation or fish spawning. Shading from barges is restricted to the in-water work window in each year of work, and are small in scale and of temporary duration, so shade from this source is not expected to have an appreciable effect on available prey communities. Thus, the potential effects from loss of benthic habitat are considered minor, with very little change in value for either juvenile migrating or rearing salmonids, though some reduction in carrying capacity may result from the isolation of the work area restricting rearing and foraging opportunities.

Substrate characteristics are important in spawning reaches, both for eulachon and for salmonids. None of species has identified spawning in the action area, therefore changes in substrate during work are not expected to influence any PBF for the species considered in this consultation.

Natural Cover

Cover is a PBF for salmonids only, serving both rearing and migration values. Approximately 1.03 acres of densely vegetated riparian habitat consisting mature trees and understory will be removed for project construction. Riparian removal is within the WSDOT right-of-way between the two existing bridges, under the northbound bridge and along existing roads that serve the State Park. Revegetation will occur to impacted areas after completion of the bridge replacement. Although revegetation will occur, there will be a temporal loss of riparian function associated with removal, lasting for up to 10 years while replanted trees mature and re-establish, shade, cover, and detrital prey input. Thus, secondary effects from removing this vegetation in the project area may lead to additional erosion due to loss of streambank stability, increased temperatures due to loss of streambank shading, reduced prey levels, and loss of large woody material input. While cover is not a feature of eulachon critical habitat, the secondary effects on shade (temperature) and water quality would be detriments for eulachon migration corridor values.

To summarize the effects on critical habitat, PBFs will be impaired during the construction period each year for 4 years, with a 2 year reduction in habitat/resource availability while the work areas are isolated from the river. At completion, the project is likely to have detrimental water quality effects, and a multiple year reduction in riparian vegetation that may also incrementally increase summer stream temperatures and reduce available prey. The project also improves over existing conditions by reducing the need for maintenance events that would also have effects on fish and habitat, and by placing the new bridge at a higher elevation, allowing increased light penetration to the water and vegetation below, which may slightly improve prey and migration values.

2.4.2 Effects on Listed Species

Individuals from all five species will be exposed to, and respond to each of the habitat effects described in Section 2.4.1, though the duration and intensity of exposure will vary by species. Construction activities have the potential to expose listed fish species to increases in turbidity and suspended sediment levels, elevated underwater sound SPLs, impacts from riparian vegetation removal and stream obstructions, shading effects, and potential capture and handling during worksite isolation (salmonids only). Permanent post-construction water quality effects due to the discharge of stormwater have the potential (depending on the scenario selected) to expose salmonids and eulachon, long-term, to contaminants above biological thresholds.

Steelhead are likely to have the greatest exposure because of their typical 2 year freshwater rearing behavior; however, the lack of quality rearing habitat in the action area diminishes the risk of exposure. Adult summer steelhead could migrate through the action area to upstream spawning areas near the end of the construction period during September and October of the in-water work window. Coho juveniles would have the next most extensive exposure based on their 1 year freshwater rearing behavior. However, as with steelhead, few are expected to be present due to the lack of quality rearing habitat in the action area. Adult coho salmon typically return to the East Fork Lewis River from September, October, and into November, and may be exposed to in-water construction and pile-driving. Fall Chinook salmon typically enter the Lewis River in September and usually finish their migration by the end of October, and may be exposed to in-water construction and pile-driving. Fall Chinook salmon emerge in early spring and migrate to the lower Columbia River by May before in-water work begins. Spring Chinook adults are typically hatchery strays into the East Fork, with peak entry in April. Most juvenile spring Chinook emigrate from fresh water as yearlings, typically in the spring of their second year; however, some migrate in the fall and early winter into large rivers. Juvenile chum salmon have a brief presence in the river after emerging in the spring. Eulachon eggs and larvae would be present for a significant portion of the year, before the in-water work window opens. They would not present during in water construction activities but will be exposed to seasonal stormwater runoff. Chum and eulachon would have the lowest duration of exposure because they move upstream quickly as adults and emigrate shortly after emerging (chum) or quickly drift through the action area as eggs/larvae (eulachon) and will likely have moved dowstream of the project action area before the in-water work begins in July.

Water Quality

As described above, water quality will be affected by turbidity, contaminants, and temperature changes. Listed species will experience these as eggs, larvae, rearing juveniles, migrating juveniles, and/or migrating adults, depending on construction timing, species, life history behaviors, and whether the source of the water quality change is temporary or permanent. Loss of streamside vegetation has the potential to cause reduced growth, fitness and juvenile salmonid survival due to degraded water quality from erosion, temperature changes, and decreased large wood and terrestrial prey input.

Sediment: Exposure individual salmonids to elevated suspended sediment would likely include behavioral disturbances and possible injury, such as gill abrasion or elevated cortisol levels. The effects of turbidity on fish are somewhat species and size dependent. In general, severity typically increases with sediment concentration and duration of exposure, and decreases with the increasing size of the fish. Exposure is most likely to occur during dewatering, rewatering and pile removal within the in water work window of July 1 to October 31 and pile installation within the in water work window of July 1 to September 30 when eulachon are out of the system and the fewest number of salmonids are expected to be present. Juvenile fish that remain in the system are most likely to be coho, spring Chinook, and steelhead. Still, few are expected to be present during in-water construction due to the lack of quality rearing habitat in the action area. Predicted responses by listed salmonids exposed to short periods of moderate levels of turbidity are low and may include avoidance and/or alarm. The severity of effect of suspended sediment on fish increases as a function of sediment concentration and duration of exposure, or dose. Juvenile salmon exposed to 600 milligrams per liter for up to one day experience mild physiological stress (Newcombe and Jenson, 1996). However, as described below, water quality investigations typically use turbidity levels to quantify suspended sediment levels, due to ease of collection in the field, and do not report concentrations. Because turbidity is influenced by many factors, conversion of turbidity measures into units of concentration can be unreliable.

Monitoring for the intensity of turbidity is measured in Nephelometric Turbidity Units (NTUs), which describe the cloudiness caused by the suspended sediments. Suspended sediments are considered to adversely affect water quality for fish and fish habitat when the background level is increased by 20 NTU for a period of four hours or more (Berg and Northcote 1985; Robertson et al. 2006). Dewatering will be isolated and rewatering are done slowly to minimize turbidity. Pile driving and removal will occur over many days, in multiple seasons. These daily events are relatively short in duration, thereby limiting the exposure of individuals. These actions will be monitored to ensure that turbidity generated by in water work will not exceed five NTUs above background stream levels 300 feet downstream of the source.

<u>Contaminants</u>: Highways collect a variety of pollutants from vehicular traffic and are disproportionate contributors to overall pollutant loads in water bodies (Wheeler et al. 2005). Because they are prevalent in stormwater, they are biologically active at low concentrations, and they have adverse effects on salmonids, DCu and DZn are constituents of notable concern (Sprague 1968; Sandahl et al. 2007). Even at very low levels, chronic exposures to contaminants from road runoff can have a wide range of adverse effects on the ESA-listed species considered in this opinion. Olfactory responsiveness in juvenile salmonids in freshwater laboratory studies are reduced by DCu (Baldwin et al. 2003), and fish have shown avoidance reactions to elevated levels of DZn (Sprague 1968), which can be fatal to salmon in high concentrations (Mackenzie and McIntyre 2017). Additional effects include reduced growth, altered immune function, and decreased predator avoidance in exposed individuals.

The intensity of effects depends largely on the pollutant, its concentration, and/or the duration of exposure. However, the incremental addition of small amounts of these pollutants are a source of potential adverse effects to salmon and steelhead, even when the source load cannot be distinguished from ambient levels. Some contaminants accumulate in both the tissues and prey of salmon and steelhead and cause a variety of lethal and sublethal effects (Hecht et al. 2007). Repeated and chronic exposures, even at very low levels, are still likely to injure or kill individual fish, by themselves and through synergistic interactions with other contaminants already present in the water (Baldwin et al. 2009; Feist et al. 2011; Hicken et al. 2011; Spromberg and Meador 2006; Spromberg and Scholz 2011).

In addition to TSS and brake metals, recent studies have shown that coho salmon show high rates of pre-spawning mortality when exposed to chemicals that leach from tires (McIntire et al. 2015). Researchers have recently identified a tire rubber antioxidant as the cause (Tian et al. 2020). Although Chinook did not experience the same level of mortality, tire leachate is still a concern for all salmonids. Traffic residue also contains many unregulated toxic chemicals such as pharmaceuticals, polycyclic aromatic hydrocarbons (PAHs), fire retardants, and emissions that have been linked to deformities, injury and/or death of salmonids and other fish (Trudeau 2017; Young et al. 2018).

Although the predicted concentration levels of the discharge are below lethal levels for DZn and DCu, and the dilution zones are extremely small, juvenile salmonids and larval eulachon are likely to be exposed to chronic low levels of to a wide array of contaminants, including fuels and oils, PAHs, and road and tire wear. Steelhead, coho, and spring Chinook, with their longer freshwater residency periods, will have longer exposure to these persistent, low level stormwater effects, and thus are likely to experience latent effects from exposure. Coho are particularly vulnerable, experiencing high rates of mortality regardless of lifestage and duration of exposure.

Temperature: By removing mature riparian vegetation, shade and evapotranspiration cooling effects are reduced in a reach that is 303(d) listed for excessive temperature. Shade from temporary and/or permanent structures may minimize some of that reduction, however concrete components of structures themselves absorb radiant heat during the day and disperse it back into the environment, especially in the summer (Huang et al 2008; Sen and Roesler 2017), though the composition of the concrete can influence the degree of thermal conductivity (Kahn 2002). Replanting of the riparian vegetation should provide increasing canopy, shade, and evapotranspiration to re-establish cooling values to the riverine habitat, but this may take up to 10 years to become appreciable. Response to warm conditions in the freshwater environment depend on a variety of factors, such as acclimatization opportunity, and will vary by species and life stage, but warmer temperatures generally increase metabolic demand of juvenile salmonids, may reduce growth, and can increase the risk of disease, and mortality, particularly when coupled with other ambient stressors, such as high turbidity, and competition for space (McCullough, 1999).

Underwater Noise

Almost the entirety of the 0.5 mile river distance will experience noise levels that can injure or kill fish less than 2 grams. Impact pile driving will exceed ambient levels in 0.5 mile of the river. Any sized fish within the majority of this distance may be exposed to injury or death from barotrauma, while fish slightly further out will experience behavioral disturbance (Figure 2). Impact pile driving will only be used to proof the piles to the desired depth. For fish over 2 grams, the zone of injury is reduced by almost half. Although the action will result in underwater SPLs that could injure fish, the extent of the area and duration is limited as described above. Juvenile coho, steelhead, and spring Chinook, particularly those in their first year of freshwater rearing, are the species likely to be in the action area (though at reduced numbers due to suboptimal rearing habitat) and are within the size range that would be most vulnerable to detrimental effects of sound.

The elevated SPLs from impact and vibratory driving are also recorded at noise levels that have caused behavioral effects on fish. These effects could include an impediment to migration or forage. Potential exposure to increased SPLs from pile driving will be limited to the time of year when salmonids are least likely to occur and are present in the fewest numbers. No life stages of eulachon will be exposed to elevated SPLs due to lack of overlap between work timing and species immigration and spawning.

Shade

Because a temporary traffic bridge or the new permanent bridge creates shade between the existing bridges, and the height of temporary platforms is unknown, light penetration would be reduced during construction over multiple years. The increased shade could cause juvenile fish to interrupt forage or may reduce production of primary prey sources that reverberate through the food chain. Salmonids are known to interrupt their movement when they encounter a stark light/dark contrast, and hesitate to enter darkened areas (Ono et al. 2010).

Many non-native piscivorous predators (large/small mouth bass/ pike minnow) use shade to gain an advantage, as a fish in shade can spot a fish in sunlight about 2.5 times further away than it can be seen itself. Shade from structures may increase prey vulnerability during emigration and may increase predator foraging success, creating profitable feeding locations. Increased consumption of juvenile salmon by predatory fish near structures has been attributed to disorientation, increased transit time through migratory reaches, and predator aggressions (Sabal et al. 2016).

Prey Reduction/Reduced Rearing Habitat

Temporarily installing cofferdams will isolate a maximum of 20,000 ft^2 of the East Fork Lewis River below the OHWM and will be left in place over two winters. The exclusion of rearing and foraging opportunities is likely to displace some juveniles into adjacent areas to seek out prey resources, and this can result in territorial behavior as competition for prey increases. Size of territory increases when prey availability decreases (Keeley 2000), with the larger fish controlling the territory and excluding smaller fish (Grant and Kramer 1990). Early life stage survival is a function of size and density of fish to available prey; in other words a fixed amount of prey will support more fish that are smaller, or fewer fish that are bigger, but bigger fish control more territory and limit smaller fish from accessing the prey, effectively ensuring a limit on carrying capacity (Marschall and Crowder 1995). Minor decreases in prey availability is unlikely to cause any detectable effects on the fitness and normal behaviors of salmonids or drifting eulachon larvae in the action area.

Stream Isolation and Fish Handling

In addition to the habitat effects described above, listed salmonids will experience two other effects directly. Cofferdams will be installed during construction to isolate the work area, but placed to permit both upstream and downstream passage of listed fish and their prey. The dammed area will slightly constrict the area for volitional movement through the streams. Isolation and dewatering sections of the stream will also require removing fish from the isolated area.

The FHWA gave no estimate of the number salmon and steelhead that may be exposed to fish salvage activities. A recent Opinion completed for restoration activities in the Pacific Northwest Region estimated that up to 5% of the captured fish would be seriously injured or killed by fish salvage activities (NMFS 2013b). We expect that the majority of the handled fish will be juvenile coho and steelhead.

In summary, adverse effect pathways from the proposed project include fish handling, obstruction of the stream corridor, and degraded water quality from turbidity, loss of riparian cover, shade and stormwater and are anticipated to compromise fitness of exposed salmonids. These pathways are likely to adversely affect physical and biological features of designated critical habitats as well as salmon, steelhead and eulachon individuals at different life stages in various ways ranging from disturbance to death.

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 in the environmental baseline (Section 2.3). Regardless, listed salmonids and eulachon are expected to be adversely affected by changes in stream flows, water quantity, elevated temperatures, frequency of storms, and severity of storms. Climate change is also expected to alter ocean conditions including reducing prey abundance, increasing water temperature, and increasing habitat for predators on salmonids and eulachon.

Table 20 in the BA (FHWA 2020, p. 69) lists the future state, local, and private projects within the action area. Most of the projects were determined to have a low or discountable risk of impacts to listed species for a variety of reasons, including: location in developed areas, lack of impacts to native habitat, lack of impacts to aquatic habitat, etc. Projects were also identified as having moderate or high risk of impacts to listed species due to potential stormwater discharges, reduction of riparian cover, shading, and in-water disturbance.

Human population density in the city of La Center and surrounding areas within the larger Lewis River watershed is reasonably certain to increase in future years and contribute to cumulative effects. This anticipated growth will increase contaminant loading from wastewater treatment plants, traffic, stormwater runoff, and sediments that recruit into the action area's waters from agricultural and non-point sources. Impacts from population growth in the watershed are reasonably likely to have cumulative adverse effects on eulachon and salmon critical habitats through two primary mechanisms: First, we anticipate increased residential and commercial development and associated road construction in the foreseeable future for this watershed. This growth-induced development is anticipated to increase the use and application of pesticides, fertilizers, and herbicides, which will increase the delivery of contaminants into the waters of the action area. Secondly, increased demand on water resources from the basin from growth (e.g. for agriculture, residential and/or municipal use) will further limit the use of those water resources to support eulachon and salmon critical habitats. Non-federally permitted water diversions alter habitat in freshwater systems by affecting stream flows, and potentially causing entrainment—an effect particularly hard to avoid for eulachon larvae and eggs for which no screening guidelines have been developed. As stream flows are reduced from diversion, contaminants can also become more concentrated in these systems, exacerbating contamination issues.

Although these factors are ongoing to some extent and likely to continue, the future level of activity will depend on whether there are economic, administrative, and legal impediments or safeguards in place. Therefore, NMFS finds it likely that the cumulative effects of these activities will have adverse effects on population abundance and productivity for Chinook salmon, coho salmon, chum salmon, and steelhead and critical habitats for these salmonid species, with similar effects to eulachon and eulachon critical habitat.

2.6 Integration and Synthesis

The Integration and Synthesis section is the final step in our assessment of the risk posed to species and critical habitat as a result of implementing the proposed action. In this section, we add the effects of the action (Section 2.4) to the environmental baseline (Section 2.3) and the cumulative effects (Section 2.5), 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) appreciably reduce 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.

Considering the status of the ESA-listed species, all four salmonid species and eulachon considered in this opinion are threatened with extinction. Adult and juvenile LCR steelhead, adult and juvenile LCR Chinook salmon, adult CR chum, and adult and juvenile LCR coho salmon have the potential to be exposed to construction temporary effects including the adverse effects of turbidity, fish exclusion during work area isolation, and sound pressure waves from impact pile driving that reduce exposed individual's fitness. All life histories of the four salmonid species and eulachon will be exposed to the ongoing effect resulting from stormwater runoff into the East Fork of the Lewis River. The specific populations of salmonids affected by the proposed action are all at low to very low probability of persistence with the exception of winter steelhead, with moderate probability of persistence. However, all of the salmonid populations are considered priority populations with a recovery target of high probability. The baseline conditions in the action area are most notably affected by poor water quality, with coliform and warm temperatures warranting a 303(d) listing. Recovery goals for the East Fork Lewis River, consistent with other tributary habitats, are to add habitat complexity, floodplain connectivity, and riparian vegetation to improve conditions for juvenile survival during rearing lifestages.

Population Level Effects: We add the project effects to the baseline to determine population level effects. Construction will affect approximately 0.5 mile of East Fork Lewis River habitat. The project site provides migration and rearing habitat for listed salmonid species. In-water construction of July 1 to October 31, with pile driving limited to July 1 to September 30, is scheduled to avoid the peak juvenile salmonid outmigration and returning adults, meaning that per construction period, only a relatively small number of fish are likely to be affected by construction effects in each of the 4 years of construction. Working during the proposed window(s) minimizes the number of individuals exposed to turbidity and elevated underwater sound waves. Due to timing of in-water work and high quality spawning and rearing habitat upstream, the vast majority of each East Fork Lewis River salmonid population will pass through the action area without experiencing the effects of construction-related stressors. Although juvenile coho, spring Chinook, and steelehead experience extended freshwater residency, salmonid smolts spend very little time (on the order of a few days) in the lower reaches due to a lack of habitat features and high water temperatures (NMFS 2015c). Based on life-history behaviors, effects are most likely to occur among rearing fish of these three species. Four cohorts of coho and spring Chinook, and up to 8 cohorts of steelhead will be affected, because coho and spring Chinook have a 1 year freshwater residency, but steelhead typically rear in freshwater for 2 years. These cohorts, along with two cohorts of fall Chinook and two cohorts of chum, will also be exposed to some migration and rearing habitat losses while the action area has a portion of in-water habitat isolated from the river. Short and long term habitat based effects, and handling effects when considered together, are not likely to reduce abundance of chum, or eulachon in an appreciable amount, however there is likely to be exposure and response among rearing coho, spring Chinook, and steelhead that abundance will be reduced in each year of construction.

Stormwater discharges will occur continuously year-round, regularly overlapping with the presence of listed species in the East Fork Lewis River. Discharges will occur into the river at a variety of depths, depending on seasonal flows and discharge location, and can range between 1 and 20 feet deep. The migration of salmonids and eulachon adults will be rapid at or near the stormwater outfalls and project stomwater discharges will be intermittent and in unpredictable pulses. Eulachon spawning has been documented upstream of the action area and drifting larvae would be present and exposed for a significant portion of the year. Rearing salmonids are likely to have much more extensive exposure. Mortality events among coho, steelhead, and spring Chinook are likely to occur every year, when juveniles and prespawn adults are exposed.

For eulachon, the East Fork and mainstem (North Fork) Lewis River population's contribution to the entire DPS has historically been a tiny fraction of the Cowlitz River and the mainstem Columbia River run. It is difficult to provide adequate context to what this project means to the overall eulachon DPS due in part to inconsistent home river fidelity and straying, run timing, and insufficient baseline population knowledge. The NMFS does not expect that Lewis River population of eulachon will be detrimentally affected by these project effects each year. However, in some years stormwater runoff is expected to have a greater impact (lower adult returns) than other years (high adult returns).

Recovery actions for eulachon in the Lewis and Columbia rivers are unlikely to be impeded by the proposed action because they are widely spread throughout the Columbia River Basin; therefore, we do not anticipate the recovery trajectory of the entire DPS being affected. Recovery information will be gained by monitoring run timing in the East Fork Lewis River which adds to our limited knowledge of this species. Replacing invasive vegetation with native species in the riparian area will also further assist recommended recovery actions (NMFS 2017).
The stormwater effects on listed salmonids and eulachon will be intermittent and unpredictable. Some individuals may experience compromised health from exposure to stormwater contaminants but the vast majority will pass through quickly without long-term exposure or short-term exposure at lethal or sub-lethal levels. Thus, those affected individuals represent a small fraction of their populations. Effects of the proposed action may create some delay in establishing abundance and productivity levels for steelhead achieving high probability of persistence, particularly summer steelhead which are at low probability as a baseline matter. Similarly, achieving coho recovery objectives may be delayed by adding project effects on 4 cohorts, and the continuing exposure to degraded stormwater with its potential for lethal response.

<u>Habitat conservation value effects</u>: The proposed action adds several habitat degradations to the action area, most of which are temporary. Construction will require isolation of a small area (compared to the available designated critical habitat in the action area) of aquatic habitat for 2 years, several months of underwater sound each year for two years, turbidity and shade each year for 4 years, and up to 10 years of reduced riparian vegetation. We do not expect these effects to reduce the value of the habitat for meeting the migration role for either adults or juveniles of any species. Rearing habitat values are likely to be slightly reduced for up to 10 years, with the most notable reduction in the first 2 years and ameliorating to baseline levels subsequently. Because habitat values will recover to their baseline level, we consider the conservation role of the action area for migration and rearing is largely retained.

When the expected long-term stormwater effects of the action are considered together with t the cumulative effects associated with future state, tribal, local, and private actions, we expect a chronic and incremental reduction in the overall water quality condition of critical habitat available in the East Fork Lewis River. The proposed action will maintain some aspects of the baseline, and exacerbate other conditions of the baseline which may reduce population abundance among East Fork Lewis River coho and steelhead. It is very difficult to translate reductions in juvenile populations to reduced productivity overall. Due to the project construction timing and intermittent, short term pulses of stormwater effects within limited distances of overall habitat, the proposed action is not expected to adversely affect designated critical habitat to such an extent that the PBFs would no longer function as intended. Designated critical habitat within the action area will not be prevented from providing the intended conservation role for the species at the watershed scale.

Riverine systems are likely to have a range of changes associated with increasing variability of climate, including more intense episodes of flooding, more frequent and more extended periods of low flow, and chronically warmer water temperatures. In systems that have modified flow regimes due to impoundments for flood control, hydropower, or irrigation, climate change may compound habitat impairments caused by upstream dams. Such is the likelihood for the proposed project action area and the listed species and critical habitats in the East Fork Lewis River.

For the reasons described in the preceding paragraphs of this section, we anticipate the proposed action will not appreciably reduce the likelihood of both survival and recovery of the ESA-listed species covered in this opinion in the wild by reducing their numbers, reproduction or distribution nor will the proposed action appreciably diminish the value of their designated critical habitats.

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 cumulative effects, it is the NMFS' biological opinion that the proposed action is not likely to jeopardize the continued existence of LCR Chinook salmon, LCR steelhead, LCR coho salmon, CR chum salmon, and the southern DPS of Pacific eulachon, or destroy or adversely modify their designated critical habitats.

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). "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 incidental take statement (ITS).

The NMFS has not yet promulgated an ESA section 4(d) rule prohibiting take of threatened eulachon. Therefore to the extent this ITS contains RPMs and terms and conditions that address requirements other than monitoring, those are voluntary until any future 4(d) rule goes into effect. However, our jeopardy analysis is based on anticipated levels of eulachon incidental take and so we have included a take indicator for eulachon that will function as a reinitiation check on that jeopardy conclusion. Monitoring requirements related to the take indicator go into effect immediately so that there is a way to know if the reinitiation trigger has been exceeded [50 CFR 402.14(i)(3)].

2.8.1 Amount or Extent of Take

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

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

Take in the form of harm to adult and juvenile LCR steelhead, adult and juvenile LCR Chinook salmon, adult CR chum, and adult and juvenile LCR coho salmon, from temporary habitat modifications due to:

- Blockage of the stream corridor from injurious noise levels from impact pile driving,
- Constriction of the stream corridor from cofferdams and other temporary structures,
- Increased overwater shading,
- Loss of riparian cover,
- Reduced prey availability
- Water quality reductions (turbidity and temperature)

Take in the form of harm to adult and juvenile LCR steelhead, adult and juvenile LCR Chinook salmon, adult CR chum, and adult and juvenile LCR coho, and all life stages of Southern DPS eulachon from habitat modifications due to:

- Long-term water quality reductions from stormwater runoff

Take in the form of capture or direct mortality to LCR Chinook salmon, LCR coho, and LCR steelhead from:

- Fish handling during dewatering and exclusion from in-water work,
- Sound from impact pile driving.

Density information is not available and therefore it is not possible to reliably enumerate or monitor the number of individuals exposed to the project stressors during construction. The NMFS cannot predict with meaningful accuracy the number of ESA-listed fish that are reasonably certain to be harmed, injured or killed by that exposure. The distribution and abundance of fish that occur within an action area are affected by habitat quality, competition, predation, and the interaction of processes that influence genetic, population, and environmental characteristics. These biotic and environmental processes interact in ways that may be random or directional, and may operate across far broader temporal and spatial scales than are affected by the proposed action.

When NMFS cannot precisely predict the number of fish that are reasonably certain to be harmed, captured, or killed we rely on a surrogate measures for take, called an extent of take. The most appropriate surrogates for take are action-related parameters that directly relate to the magnitude and duration of the expected take. In such circumstances, the NMFS uses the causal link established between the activity and the likely extent and duration of changes in habitat conditions to describe the extent of take as a numerical level of habitat disturbance.

The extent of take in the form of harm from reduced migration and rearing habitat is the area to be dewatered over two winter seasons (for 3 in-water construction years): a maximum of 20,000 ft^2 of habitat below the OHWM in the East Fork Lewis River.

The amount of injury or death from handling is limited to no more than 5% of the total number handled when isolating the area(s).

The extent of take in the form of harm from turbidity plumes generated during construction activities (stream dewatering, pile driving, potential barge grounding, and rewatering the channel) is 300 feet downstream from the source in each in water work window over 4 years. The extent of take in the form of harm from shade caused by temporary structures (work platforms and temporary traffic bridge) will not exceed 15,500 ft^2 for up to 3 years.

Take in the form of injury or death and harm from blockage through migration and rearing habitat from elevated in water noise from impact pile driving for fish weighing less than 2 grams is 0.25 miles upstream and 0.25 miles downstream of the project site and limited to two in water seasons from July 1 to September 30.

The extent of take in the form of harm from reduced cover is 1.03 acres of mature riparian vegetation removal, over a re-establishment period of up to 10 years.

The extent water quality is degraded by stormwater discharges is from the point at which the stormwater enters the East Fork Lewis River and extending downstream at least to the point that it reaches the confluence with the Lewis River. In the case of this proposed action, the amount of new PGIS is not the proper parameter to assess stormwater impacts based on the proposed treatment alternatives. Take is thus defined as the downstream point at which discharge is modeled to no longer exceed the biological thresholds for DZn and DCu under either the baseline model or the post project model. As determined by all model outputs, the extent of take in the form of harm from water quality degradation from stormwater discharges is less than 12 inches in the East Fork Lewis River.

These surrogate quantities are valid reinitiation triggers because, with monitoring and reporting, the FHWA can take remedial action if the construction effects from turbidity, noise, and temporary structures or stormwater output affect more habitat than proposed.

2.8.2 Effect of the Take

In the opinion, the 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" (RPMs) are nondiscretionary measures that are necessary or appropriate to minimize the impact of the amount or extent of incidental take (50 CFR 402.02).

The FHWA shall:

1. Minimize incidental take of LCR salmonids associated with obstruction of habitat.
2. Minimize incidental take of LCR salmonids associated with project site dewatering and fish handling.
3. Minimize incidental take of LCR salmonids associated with construction related turbidity.
4. Minimize incidental take of LCR salmonids associated with impact pile driving.
5. Minimize incidental take of LCR salmonids associated with temporary shading.
6. Minimize incidental take of LCR salmonids associated with temporary loss of riparian cover.
7. Minimize incidental take of LCR salmonids and eulachon associated with long-term exposure to stormwater pollutants.
8. Ensure completion of a monitoring and reporting program to confirm this Opinion is meeting its objective of limiting the extent of take and minimizing take from permitted activities. Please electronically send these reports to: projectreports.wcr@noaa.gov

2.8.4 Terms and Conditions

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

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

    a. Isolate the smallest area of the stream necessary to complete the project.
    b. Leave the cofferdams in place no more than three in water construction years and over two winter seasons.
    c. Remove the cofferdams no later than two in-water construction seasons after they are installed.

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

   a. Perform fish removal monitoring to identify:
      i. Methods used to isolate the work area and minimize disturbances to ESA-listed species.
      ii. Fish removal methods used.
      iii. Number and age/size class of fish removed from by species.
      iv. Number of fish killed and number of fish injured by species. Any explanation of the cause of death or injury and follow up actions taken in response to death or injury.
      v. Overall percent mortality for each handling event.

3. The following terms and conditions implement reasonable and prudent measure 3:

   a. Monitor turbidity during in-water work and document the duration of exposure to plumes 20 NTU or greater above background levels.
   b. If turbidity plume exceedances of 5 NTU above background beyond 300 feet from the source are a reoccurring issue, put and maintain additional turbidity management BMPs, including a silt curtain, in place.

4. The following terms and conditions implement reasonable and prudent measure 4:

   a. Only use an impact hammer to proof piles when absolutely necessary.
   b. Cease pile driving for the day once 900 impact strikes have been reached.
   c. Perform monitoring of impact pile driving to identify:
      i. Number of piles installed each day
      ii. Number of impact strikes required each day.
      iii. Total duration of pile driving each day.
      iv. Use of the bubble curtain.
      v. Any observations of fish in distress or killed during the activity.
      vi. Dates of initiation and completion of impact pile driving.

5. The following terms and conditions implement reasonable and prudent measure 5:

   a. Confirm that the finished design size of all temporary over water structures does not exceed 15,500 square feet.
   b. Confirm that the finished design height of the temporary traffic bridge is at least 25 feet above the OHWM.

6. The following terms and conditions implement reasonable and prudent measure 6:

   a. Confirm that no more than 1.03 acres of riparian vegetation is removed.
   b. Restore riparian vegetation along streambanks as soon as possible after completion of construction.
   c. Ensure replanted vegetation is a variety of native plants that will create a shade canopy where possible.

d. Ensure 85% survival of planted vegetation.
   i. Monitor plant survival for 5 years.
   ii. Replant failed plants annually to meet minimum survival rate.
   iii. If replanting is outside of the rainy seasons, ensure there is supplemental water provided to the revegetated areas.

7. The following terms and conditions implement reasonable and prudent measure 7:

   a. Ensure the stormwater facilities are built as proposed and as relied-on by NMFS while conducting this consultation.
   b. Conduct routine maintenance to ensure that stormwater treatment facilities function as appropriate to remove stormwater pollutants.

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

   a. Reporting: The FHWA must report to NMFS and projectreports.wcr@noaa.gov all monitoring items within 90 days of project completion, including:
      i. Dimensions of the dewatered area and dates cofferdams are installed and removed.
      ii. Turbidity and/or State Water Quality monitoring logs with a discussion of implementation of the terms and conditions in #3, above.
      iii. The dimensions and height of all temporary over water structures above the OHWM and dates of installation and removal.
      iv. The total pre- and post-project amount of pollution generating impervious surface in acres and the net increase in pollution generating impervious surface. Provide the final design of stormwater treatment BMPs.
      v. Fish salvage logs collected during dewatering and handling activities, as described in the Documentation section of the NMFS approved WSDOT Fish Removal Protocol and Standards [see 2(a) above].
      vi. Pile driving logs collected during impact pile driving [see 4(c) above].
      vii. Annual dates of initiation and completion of in-water work.
      viii. Verification that all BMPs and minimization measures were implemented.
      ix. Any exceedance of take covered by this opinion.

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).

NMFS has identified the following measures to further minimize or avoid adverse effects on listed species:

1. Construct additional stormwater BMPs to provide runoff treatment of all PGIS in the project area.
2. Confine all in water work to the shorter work window provided for impact pile driving (July 1 to September 30).
3. Place all temporary over water structures with the maximum vertical clearance above the OHWM feasible for construction.
4. Construct a pocket off-channel habitat area for overwinter rearing juvenile salmonids upstream of the point of stormwater discharge.
5. Submit juvenile salmonids killed during capture/handling for genetic analysis to determine stock origin and include results in fish monitoring reports.

2.10 Reinitiation of Consultation

This concludes formal consultation for the FHWA's proposed replacement of the I-5 East Fork Lewis River Northbound Bridge.

As 50 CFR 402.16 states, reinitiation of consultation is required and shall be requested by the Federal agency or by the Service where discretionary Federal agency involvement or control over the action has been retained or is authorized by law and if: (1) The amount or extent of incidental taking specified in the ITS is exceeded, (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion, (3) the identified action is subsequently modified in a manner that causes an effect to the listed species or critical habitat that was not considered in the biological opinion, or (4) a new species is listed or critical habitat designated that may be affected by the action.

2.11 "Not Likely to Adversely Affect" Determinations

This assessment was prepared pursuant to section 7(a)(2) of the ESA, implementing regulations at 50 CFR 402 and agency guidance for preparation of letters of concurrence.

As described in section 1.2 and below, the NMFS has concluded that the proposed action would be not likely to adversely affect southern resident killer whales. Detailed information about the biology, habitat, and conservation status and trends of SRKW's can be found in the listing regulations and critical habitat designations published in the Federal Register, as well as in the recovery plans and other sources at: https://www.fisheries.noaa.gov/west-coast/endangered-species-conservation/southern-resident-killer-whale-orcinus-orca, and are incorporated here by reference.

The applicable standard to find that a proposed action is not likely to adversely affect listed species or critical habitat is that all of the effects of the action are expected to be discountable, insignificant, or completely beneficial. Beneficial effects are contemporaneous positive effects without any adverse effects to the species or critical habitat. Insignificant effects relate to the size of the impact and should never reach the scale where take occurs. Discountable effects are those extremely unlikely to occur. The effects analysis in this section relies heavily on the descriptions of the proposed action and project site conditions discussed in Sections 1.3 and 2.3, and on the effects analyses presented in Section 2.4.

Southern Resident Killer Whale: The SRKW DPS, composed of J, K and L pods, was listed as endangered under the ESA on November 18, 2005 (70 FR 69903), and the listing was revised in 2015 (80 FR 7380) to include captive SRKW Lolita. A 5-year status review under the ESA completed in 2016 concluded that SRKW should remain listed as endangered and includes recent information on the population, threats, and new research results and publications (NMFS 2016). The limiting factors described in the final recovery plan included reduced prey availability and quality, high levels of contaminants from pollution, and disturbances from vessels and sound (NMFS 2008). During the winter months, SRKWs predominantly feed on Chinook at the mouth of the Columbia River, primarily those from the LCR ESU (Hanson et al. 2021).
In September 2019, NMFS proposed to revise the 2006 critical habitat designation by designating six new areas along the West Coast studies suggest an overall preference for Chinook salmon, despite the much lower abundance of Chinook in some areas and during certain time periods compared to other salmonids. Most of the Chinook prey samples obtained while the whales were in outer coastal waters were determined to have originated from the Columbia River basin, including Lower Columbia spring Chinook. The same three PBFs remain essential for the conservation of the SRKW, including prey species of sufficient quantity, quality and availability to support individual growth, reproduction and development, as well as overall population growth. Due to its significance as a winter feeding area, the mouth of the Columbia River is included in the proposed revision as the Coastal Washington/Northern Oregon Inshore Area.

Because SRKWs are limited to marine water habitats, they would not be directly exposed to any project-related effects. Still, they could possibly be exposed to indirect effects through the trophic web. The LCR Chinook population would be affected by the proposed action and, as described in Sections 2.2 and 2.3, is extremely small when compared to historical numbers. Further, as described in Section 2.4, the proposed action would affect too few individuals annually to cause detectable population-level affects to LCR Chinook. The total number of individuals, particularly Chinook salmon, affected by this project are expected to be inconsequential to supporting sufficient prey abundance to measurably affect SRKWs. Similarly, although some juvenile Chinook salmon would be exposed to stormwater discharges at the project site, their individual levels of contamination as well as the total numbers of annually exposed individuals would be too low to cause any detectable trophic link between the stormwater contaminants from this project and SR killer whales. Therefore, the action is not likely to adversely affect SRKWs.

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 FHWA and descriptions of EFH for Pacific Coast Salmon contained in the fishery management plan developed by the Pacific Fishery Management Council (PFMC) and approved by the Secretary of Commerce (PFMC 2014).

3.1 Essential Fish Habitat Affected by the Project

The waters and substrates of the project site are designated as freshwater EFH for various life-history stages of Pacific Coast salmon. Freshwater EFH for Pacific Coast Salmon is identified and described in Appendix A to the Pacific Coast salmon fishery management plan (PFMC 2014), and consists of four major components: (1) spawning and incubation; (2) juvenile rearing; (3) juvenile migration corridors; and (4) adult migration corridors and holding habitat.

Those components of freshwater EFH for Pacific Coast Salmon depend on habitat conditions for spawning, rearing, and migration that include: (1) water quality (e.g., dissolved oxygen (DO), nutrients, temperature, etc.); (2) water quantity, depth, and velocity; (3) riparian-stream-marine energy exchanges; (4) channel gradient and stability; (5) prey availability; (6) cover and habitat complexity (e.g., large woody material, pools, aquatic and terrestrial vegetation, etc.); (7) space; (8) habitat connectivity from headwaters to the ocean (e.g., dispersal corridors); (9) groundwater-stream interactions; and (10) substrate composition.

As part of Pacific Coast Salmon EFH, five Habitat Areas of Particular Concern (HAPCs) have been defined: 1) complex channels and floodplain habitats; 2) thermal refugia; 3) spawning habitat; 4) estuaries; and 5) marine and estuarine submerged aquatic vegetation. The action area provides no known HAPCs.

3.2 Adverse Effects on Essential Fish Habitat

The ESA portion of this document (Sections 1 and 2) describes the proposed action and its adverse effects on ESA-listed species and critical habitat, and is relevant to the effects on EFH.

Adverse effects to EFH for Pacific salmon (Chinook salmon and coho salmon) mirror those effects on critical habitats previously described in section 2.4.1 above. The proposed project construction will have episodic and temporary adverse effects on water quality and substrates, will isolate and dewater, remove riparian cover, and will drive piles in EFH in the East Fork Lewis River. Long-term adverse effects result from infrastructure permanently occupying a portion of the East Fork Lewis River and stormwater discharges.

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

To reduce adverse impacts on substrate and water quality, the FHWA should:

1. Prevent grounding of the barge(s); and
2. Use a turbidity curtain during all activities where implementation could minimize suspended sediments within the East Fork Lewis River.

Fully implementing these EFH conservation recommendations would protect designated EFH, by avoiding or minimizing the adverse effects described in section 3.2, above, for Pacific Coast salmon.

3.3 Statutory Response Requirement

As required by section 305(b)(4)(B) of the MSA, the FHWA 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.

3.4 Supplemental Consultation

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

4. DATA QUALITY ACT DOCUMENTATION AND PRE-DISSEMINATION REVIEW

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

4.1 Utility

Utility principally refers to ensuring that the information contained in this consultation is helpful, serviceable, and beneficial to the intended users. The intended users of this opinion are the FHWA, as the lead Federal Agency. Other interested users could include the COE, WSDOT, WDFW, the Cowlitz Tribe, citizens of affected areas, or others interested in the conservation of the affected ESUs/DPSs. Individual copies of this opinion were provided to the FHWA and WSDOT. The document will be available within two weeks at the NOAA Library Institutional Repository [https://repository.library.noaa.gov/welcome]. The format and naming adheres to conventional standards for style.

4.2 Integrity

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

4.3 Objectivity

Information Product Category: Natural Resource Plan

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

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

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

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

5. REFERENCES

Abatzoglou, J.T., Rupp, D.E. and Mote, P.W. 2014. Seasonal climate variability and change in the Pacific Northwest of the United States. Journal of Climate 27(5): 2125-2142.

Baldwin, D.H., J.F. Sandahl, Labenia, and N.L. Scholz. 2003. Sublethal effects of copper on coho salmon: impacts on nonoverlapping receptor pathways in the peripheral olfactory nervous system. Environ. Toxicol. Chem. 22:2266-2274.

Baldwin, D.H., J.A. Spromberg, T.K. Collier, and N.L. Scholz. 2009. A fish of many scales: extrapolating sublethal pesticide exposures to the productivity of wild salmon populations. Ecological Applications 19(8):2004-2015.

Barton, A., B. Hales, G. G. Waldbuster, C. Langdon, and R. Feely. 2012. The Pacific Oyster,*Crassostrea gigas*, Shows Negative Correlation to Naturally Elevated Carbon Dioxide Levels: Implications for Near-Term Ocean Acidification Effects. *Limnology and Oceanography* 57 (3):698-710.

Berg, L. and T.G. Northcote. 1985. Changes in Territorial, Gill-Flaring, and Feeding Behavior in Juvenile Coho Salmon (Oncorhynchus kisutch) Following Short-Term Pulses of Suspended Sediment. Canadian Journal of Fisheries and Aquatic Sciences 42: 1410-1417.

Bottom, D.L., C.A. Simenstad, J. Burke, A.M. Baptista, D.A. Jay, K.K. Jones, E. Casillas, and M.H. Schiewe. 2005. Salmon at river's end: The role of the estuary in the decline and recovery of Columbia River salmon. U.S. Department of Commerce. NOAA Technical Memorandum NMFS-NWFSC-68. 246 p.

Carrasquero, J. 2001. Over-water structures: freshwater issues. White paper submitted to Washington Department of Fish and Wildlife, Washington Department of Ecology, and Washington Department of Transportation. April 12, 2001. 127 pp.

Cowlitz Indian Tribe. 2013. Presentation on the Cowlitz Indian Tribe Eulachon Project 2010-2013.

Cramer and Associates. 2005. East Fork Lewis River Basin – Habitat Assessment. Prepared for the Lower Columbia Fish Recovery Board. Longview, WA.

Crozier, L.G., Hendry, A.P., Lawson, P.W., Quinn, T.P., Mantua, N.J., Battin, J., Shaw, R.G. and Huey, R.B., 2008. Potential responses to climate change in organisms with complex life histories: evolution and plasticity in Pacific salmon. *Evolutionary Applications* 1(2): 252-270.

Crozier, L. G., M. D. Scheuerell, and E. W. Zabel. 2011. Using Time Series Analysis to Characterize Evolutionary and Plastic Responses to Environmental Change: A Case Study of a Shift Toward Earlier Migration Date in Sockeye Salmon. *The American Naturalist* 178 (6): 755-773.

Dominguez, F., E. Rivera, D. P. Lettenmaier, and C. L. Castro. 2012. Changes in Winter Precipitation Extremes for the Western United States under a Warmer Climate as Simulated by Regional Climate Models. *Geophysical Research Letters* 39(5).

Doney, S. C., M. Ruckelshaus, J. E. Duffy, J. P. Barry, F. Chan, C. A. English, H. M. Galindo, J. M. Grebmeier, A. B. Hollowed, N. Knowlton, J. Polovina, N. N. Rabalais, W. J. Sydeman, and L. D. Talley. 2012. Climate Change Impacts on Marine Ecosystems. *Annual Review of Marine Science* 4: 11-37.

Dornbusch, P. and A. Sihler. 2013. ESA recovery plan for Lower Columbia River coho salmon, Lower Columbia River Chinook salmon, Columbia River chum salmon, and Lower Columbia River steelhead. National Marine Fisheries Service. Northwest Region, Portland, Oregon. 503 pp

Drake, J., R. Emmett, K. Fresh, R. Gustafson, M. Rowse, D. Teel, M. Wilson, P. Adams, E.A.K. Spangler, and R. Spangler. 2008. Summary of scientific conclusions of the review of the status of eulachon (*Thaleichthys pacificus*) in Washington, Oregon and California (Draft). U. S. Department of Commerce, Northwest Fisheries Science Center. Seattle.

Ecology. 2009. Surface water/groundwater exchange along the East Fork Lewis River (Clark County), 2005. Washington Department of Ecology. Publication No. 09-03-037.

Ecology. 2018. East Fork Lewis River Watershed Bacteria and Temperature, Source Assessment Report. Environmental Assessment Program, Washington Department of Ecology. Publication No, 18-10-019. May 2018, 135 pp.

FHWA. 2020. Biological Assessment: I-5/East Fork Lewis River Bridge NB – Replace Bridge. La Center, Washington. Prepared for FHWA and WSDOT by David Evans and Associates, Inc. Bellevue, WA. June, 2020.

FHWA, USFWS, NMFS, WSDOT. 2009. Memorandum Re: Analytic Approach to be used in Assessing Stormwater Effects in Biological Assessments. Signed February 16, 2009.

Feely, R.A., T. Klinger, J.A. Newton, and M. Chadsey (editors). 2012. Scientific summary of ocean acidification in Washington state marine waters. NOAA Office of Oceanic and Atmospheric Research Special Report.

Feist, B.E., E.R. Buhle, P. Arnold, J.W. Davis, and N.L. Scholz. 2011. Landscape ecotoxicology of coho salmon spawner mortality in urban streams. Plos One 6(8):e23424.

Ford, M.J. (editor). 2011. Status review update for Pacific salmon and steelhead listed under the Endangered Species Act: Pacific Northwest. U.S. Department of Commerce. NOAA Technical Memorandum NMFS-NWFSC-113. 281 p.

Fresh, K.L., E. Casillas, L.L. Johnson, and D.L. Bottom. 2005. Role of the estuary in the recovery of Columbia River Basin salmon and steelhead: An evaluation of the effects of selected factors on salmonid population viability. U.S. Department of Commerce. NOAA Technical Memorandum NMFS-NWFSC-69. 105 p.

Glick, P., J. Clough, and B. Nunley. 2007. Sea-Level Rise and Coastal Habitats in the Pacific Northwest: An analysis for Puget Sound, southwestern Washington, and northwestern Oregon. National Wildlife Federation, Seattle, WA.

Goode, J.R., Buffington, J.M., Tonina, D., Isaak, D.J., Thurow, R.F., Wenger, S., Nagel, D., Luce, C., Tetzlaff, D. and Soulsby, C., 2013. Potential effects of climate change on streambed scour and risks to salmonid survival in snow-dominated mountain basins. *Hydrological Processes* 27(5): 750-765.

Grant, W.A., and D.L. Kramer. 1990. Territory size as a predictor of the upper limit to population density of juvenile salmonids in streams. Can. J. Fish. Aquat. Sci. 47 pp 1724-1737.

Gustafson, R. G., L. Weitkamp, YW. Lee, E. Ward, K. Somers. V. Tuttle, and J. Jannot. 2016. Status Review Update of Eulachon (Thaleichthys pacificus) Listed under the Endangered Species Act: Southern Distinct Population Segment. US Department of Commerce, NOAA, Online at: http://www.westcoast.fisheries.noaa.gov/publications/status_reviews/other_species/eulachon/eulachon_2016_status_review_update.pdf

Gustafson, R.G., M.J. Ford, D. Teel, and J.S. Drake. 2010. Status review of eulachon (*Thaleichthys pacificus*) in Washington, Oregon, and California. U.S. Department of Commerce. NOAA Technical Memorandum NMFS-NWFSC-105. 360 p.

Hanson, M.B., Emmons, C.K., Ford, M.J., Everett, M., Parsons, K., Park, L.K., et al. 2021. Endangered predators and endangered prey: Seasonal diet of Southern Resident killer whales. PLoS ONE 16(3): e0247031. https://doi.org/10.1371/journal.pone.0247031

Hatchery Scientific Review Group (HSRG). 2009. Lewis River Spring Chinook: Population an Related Hatchery Programs. Columbia River Hatchery Reform Project. HSRG Review and Recommendations. January 31, 2009. 5 pp.

Hecht, S.A., D.H. Baldwin, C.A. Mebane, T. Hawkes, S.J. Gross, and N.L. Scholz. 2007. An overview of sensory effects on juvenile salmonids exposed to dissolved copper: Applying a benchmark concentration approach to evaluate sublethal neurobehavioral toxicity. U.S. Department of Commerce, NOAA Fisheries, NOAA Technical Memorandum NMFS-NWFSC-83. 39 p.

Hicken, C.E., T.L. Linbo, D.H. Baldwin, M.L. Willis, M.S. Myers, L. Holland, M. Larsen, M.S. Stekoll, S.D. Rice, T.K. Collier, N.L. Scholz, and J.P. Incardona. 2011. Sublethal exposure to crude oil during embryonic development alters cardiac morphology and reduces aerobic capacity in adult fish. Proceedings of the National Academy of Sciences 108(17):7086-7090.

Howell, M.D., M.D. Romano, and T.A. Rein. 2001. Outmigration Timing and Distribution of Larval Eulachon, Thaleichthys pacificus, in the Lower Columbia River, Spring 2001. Washington Department of Fish and Wildlife publications. December 26, 2001. 35pg.

Huang, L., J. Li, D. Zhoa, and J. Zhu. 2008. A fieldworkr study on the diurnal changes of the urban microclimate in four types of ground cover and urban heat island of Namjing China. Building and Enviroment. 43:1 pp 7-17.

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

Intergovernmental Panel on Climate Change (IPCC). 2014. Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland, 151 pp.

Isaak, D.J., Wollrab, S., Horan, D. and Chandler, G., 2012. Climate change effects on stream and river temperatures across the northwest US from 1980–2009 and implications for salmonid fishes. *Climatic Change* 113(2): 499-524.

Jacobsen R, Nott J, Brown E, Weeber M, Lewis M..2014. Assessment of western Oregon adult winter steelhead – Redd surveys 2014. Oregon Plan for salmon and watersheds. Monitoring Report No. OPSW-ODFW-2014-09. 27 p.

James, B.W., O.P. Langness, P.E. Dionne, C.W. Wagemann, and B.J. Cady. 2014. Columbia River eulachon spawning stock biomass estimation. Report A, in C. Mallette (Ed.), Studies of eulachon smelt in Oregon and Washington, Project completion report, July 2010-June 2013, 159 p.

Joint Columbia River Management Staff. 2009. 2010 joint staff report concerning stock status and fisheries for sturgeon and smelt. Oregon Department of Fish and Wildlife and Washington Department of Fish and Wildlife.

Kahn, M.I. 2002. Factors affecting the thermal properties of concrete and applicability of its prediction models. Building and Environment. 37:6 pp 607-614.

Keeley, E.R. 2000. An experimental analysis of territory size in juvenile steelhead trout. Animal Behavior 59(3): 477-490.

Kunkel, K. E., L. E. Stevens, S. E. Stevens, L. Sun, E. Janssen, D. Wuebbles, K. T. Redmond, and J. G. Dobson. 2013. Regional Climate Trends and Scenarios for the U.S. National Climate Assessment: Part 6. *Climate of the Northwest U.S. NOAA Technical Report NESDIS 142-6*. 83 pp. National Oceanic and Atmospheric Administration, National Environmental Satellite, Data, and Information Service, Washington, D.C.

Lawson, P. W., Logerwell, E. A., Mantua, N. J., Francis, R. C., & Agostini, V. N. 2004. Environmental factors influencing freshwater survival and smolt production in Pacific Northwest coho salmon (*Oncorhynchus kisutch*). *Canadian Journal of Fisheries and Aquatic Sciences* 61(3): 360-373.

Lower Columbia River Estuary Partnership. 2007. Lower Columbia River and estuary ecosystem monitoring: Water quality and salmon sampling report. Portland, Oregon.

Mackenzie, C., and J. McIntyre. 2018. Stormwater Quality in Puget Sound: Impacts & Solutions in Reviewed Literature 2017. The Nature Conservancy and Washington State University. November 2018.

Mantua, N., I. Tohver, and A. Hamlet. 2009. Impacts of Climate Change on Key Aspects of Freshwater Salmon Habitat in Washington State. *In* The Washington Climate Change Impacts Assessment: Evaluating Washington's Future in a Changing Climate, edited by M. M. Elsner,J. Littell, L. Whitely Binder, 217-253. The Climate Impacts Group, University of Washington, Seattle, Washington.

Mantua, N., I. Tohver, and A. Hamlet. 2010. Climate change impacts on streamflow extremes and summertime stream temperature and their possible consequences for freshwater salmon habitat in Washington State. *Climatic Change* 102(1): 187-223.

Marschall, E.A., and L.B. Crowder. 1995. Desnsity-dependent survival a s a function of size in juvenile salmonids in streams. Can J. Fish. Aqaat. Sci. 52: 136-140.

McClure, M. E.E. Holmes, B.L. Sanderson, and C.E.Jordan. 2003. A Large Scale , Multi-Species Status Assessment: Anadromous Salmonids in the Columbia River Basin. Ecological Applications, 13(4), 2003, pp. 964–989.

McCullough, D. 1999. A review and synthesis of effects of alterations to the water temperature regime on freshwater life stages of salmonids, with special reference to chinook salmon. Prepared for US EPA Region 10. EPA 910-R-99-010.

McElhany, P., M.H. Ruckelshaus, M.J. Ford, T.C. Wainwright, and E.P. Bjorkstedt. 2000. Viable salmonid populations and the recovery of evolutionarily significant units. U.S. Department of Commerce. NOAA Technical Memorandum NMFS-NWFSC-42. 156 p.

McIntyre, J.K., Davis, J., Hinman, C., Macneale, K.H., Anulacion, B.F., Scholz, N.L., and Stark, J.D. 2015. Soil bioretention protects juvenile salmon and their prey from the toxic effects of urban stormwater runoff. Chemosphere, 132:213-219.

McIntyre, J.K., Edmunds, R.C., Mudrock, E., Brown, M., Davis, J.W., Stark, J.D., Incardona, J.P. and Scholz, N.L. 2016. Confirmation of stormwater bioretention treatment effectiveness using molecular indicators of cardiovascular toxicity in developing fish. Environmental Science and Technology, In press.

McMahon, T.E., and G.F. Hartman. 1989. Influence of cover complexity and current velocity on winter habitat use by juvenile coho salmon (*Oncorhynchus kisutch*). *Canadian Journal of Fisheries and Aquatic Sciences* 46: 1551–1557.

Mote, P.W., J.T. Abatzglou, and K.E. Kunkel. 2013. Climate: Variability and Change in the Past and the Future. In Climate Change in the Northwest: Implications for Our Landscapes, Waters, and Communities, edited by M.M. Dalton, P.W. Mote, and A.K. Snover, 41-58. Island Press, Washington, DC.

Mote, P.W, A. K. Snover, S. Capalbo, S.D. Eigenbrode, P. Glick, J. Littell, R.R. Raymondi, and W.S. Reeder. 2014. Ch. 21: Northwest. *In* Climate Change Impacts in the United States: The Third National Climate Assessment, J. M. Melillo, T.C. Richmond, and G.W. Yohe, Eds., U.S. Global Change Research Program, 487-513.

Mote, P.W., D.E. Rupp, S. Li, D.J. Sharp, F. Otto, P.F. Uhe, M. Xiao, D.P. Lettenmaier, H. Cullen, and M. R. Allen. 2016. Perspectives on the cause of exceptionally low 2015 snowpack in the western United States, Geophysical Research Letters, 43, doi:10.1002/2016GLO69665.

Myers, J.M., C. Busack, D. Rawding, A.R. Marshall, D.J. Teel, D.M. Van Doornik, and M.T. Maher. 2006. Historical population structure of Pacific salmonids in the Willamette River and lower Columbia River basins. U.S. Department of Commerce. NOAA Technical Memorandum NMFS-NWFSC-73. 311 p.

Meyer, J.L., M.J. Sale, P.J. Mulholland, and N.L. Poff. 1999. Impacts of climate change on aquatic ecosystem functioning and health. *JAWRA Journal of the American Water Resources Association* 35(6): 1373-1386.

Native Fish Society. 2016. East Fork Lewis River web page. Posted June 16, 2016. Available at: https://nativefishsociety.org/watersheds/east-fork-lewis. Accessed January 19, 2021.

Newcombe, C. P. and Jorgen O.T. Jensen. 1996. Channel Suspended Sediment and Fisheries: A Synthesis for Quantitative Assessment of Risk and Impact, North American Journal of Fisheries Management, 16:4, 693-727, DOI: 10.1577/1548-8675(1996)016<0693:CSSAFA>2.3.CO;2

NMFS (National Marine Fisheries Service). 2008. Recovery Plan for Southern Resident Killer Whales (Orcinus orca). National Marine Fisheries Service, Northwest Region, Seattle, Washington.

NMFS. 2011a. Columbia River estuary ESA recovery plan module for salmon and steelhead. Prepared for NMFS by the Lower Columbia River Estuary Partnership (contractor) and PC Trask & Associates, Inc. (subcontractor). National Marine Fisheries Service, Northwest Region. Portland, Oregon.

NMFS. 2011b. Critical Habitat for the Southern Distinct Population Segment of Eulachon: Final Biological Report. Northwest Region, Protected Resources Division, Seattle, WA. 59 pp.

NMFS. 2013a. ESA recovery plan for lower Columbia River coho salmon, lower Columbia River Chinook salmon, Columbia River chum salmon, and Lower Columbia River steelhead. National Marine Fisheries Service, Northwest Region. Seattle.

NMFS. 2013b. Programmatic Restoration Opinion for Joint Ecosystem Conservation by the Services (PROJECTS) by the U.S. Fish and Wildlife Service Using the Partners for Fish and Wildlife, Fisheries, Coastal, and Recovery Programs and NOAA Restoration Center Using the Damage Assessment, Remediation and Restoration Program (DARRP), and Community-Based Restoration Program (CRP) in the States of Oregon, Washington, and Idaho. NWR-2013-10221. December 3, 2013. 228 pp.

NMFS. 2015a. Biological Opinion NWR-2013-9721. Reinitation of Endangered Species Act Section 7 Formal Consultation of the continued operation, and construction, operation and maintenance of license mandated projects for Merwin, Yale, Swift No. 1 and Swift No. 2 Hydroelectric Projects.

NMFS. 2015b. Designation of Critical Habitat for Lower Columbia River Coho Salmon and Puget Sound Steelhead, FINAL Biological Report. NMFS West Coast Region, Protected Resources Division, Portland, Oregon. December 2015.

NMFS. 2015c. Reinitiation of Endangered Species Act Section 7 Formal Consultation for the continued operation, and construction, operation and maintenance of licensed mandated projects for Merwin (FERC No. 935-117), Yale (FERC no. 2071), Swift No. 1 (FERC No. 2111), and Swift No. 2 (FERC No. 2213) Hydroelectric Projects, Lewis River, HUC 17080002, Cowlitz, Clark, and Slamania Counties, Washington. NMFS Ref. No.: NWR-2013-9721, Seattle, WA.

NMFS. 2016. Southern Resident Killer Whales (Orcinus orca) 5-Year Review. Summary and Evaluation. https://www.fisheries.noaa.gov/resource/document/southern-resident-killer-whales-orcinus-orca-5-year-review-summary-and-evaluation

NMFS. 2017. Recovery Plan for the Southern Distinct Population Segment of Eulachon (*Thaleichthys pacificus*). National Marine Fisheries Service, West Coast Region, Protected Resources Division, Portland, OR, 97232. September

NOAA Fisheries. 2005. Assessment of NOAA Fisheries' critical habitat analytical review teams for 12 evolutionarily significant units of West Coast salmon and steelhead. National Marine Fisheries Service, Protected Resources Division. Portland, Oregon.

NPCC (Northwest Power and Conservation Council). 2015. Summary of the Northwest Power and Conservation Council's Eulachon State of the Science and Science to Policy Forum.

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

Ono, K., C.A. Simenstand, J.D. Toft, S.L. Southard, K.L. Sobocinski and A. Borde. 2010. Assesing and mitigating dock shading impacts on the behavior of juvenile Pacific salon (Onchorhynchus spp.): Can artificial light mitigate the effects? WSDOT Research Report. WSDOT Office of Research and Library Services. Rep't No. WA-RD 755.1.

PFMC (Pacific Fishery Management Council). 2014. Appendix A to the Pacific Coast Salmon Fishery Management Plan, as modified by Amendment 18. Identification and description of essential fish habitat, adverse impacts, and recommended conservation measures for salmon.

Raymondi, R.R., J.E. Cuhaciyan, P. Glick, S.M. Capalbo, L.L. Houston, S.L. Shafer, and O. Grah. 2013. Water Resources: Implications of Changes in Temperature and Precipitation. *In* Climate Change in the Northwest: Implications for Our Landscapes, Waters, and Communities, edited by M.M. Dalton, P.W. Mote, and A.K. Snover, 41-58. Island Press, Washington, DC.

Reeder, W.S., P.R. Ruggiero, S.L. Shafer, A.K. Snover, L.L Houston, P. Glick, J.A. Newton, and S.M Capalbo. 2013. Coasts: Complex Changes Affecting the Northwest's Diverse Shorelines. *In* Climate Change in the Northwest: Implications for Our Landscapes, Waters, and Communities, edited by M.M. Dalton, P.W. Mote, and A.K. Snover, 41-58. Island Press, Washington, DC.

Robertson, M.J., D.A. Scruton, R.S. Gregory, and K.D. Clarke. 2006. Effect of suspended sediment on freshwater fish and fish habitat. Canadian Technical Report of Fisheries and Aquatic Sciences 2644, 37 p.

Sabal, M., S. Hayes, J. Merz, and J. Setka. 2016. Habitat alterations and a nonnative predator, the striped bass, increase native Chinook salmon mortality in the Central Valley, California. N. Am. J. Fish. Mgmt. 36:309-320

Sandahl, J.F., D.H. Baldwin, J.J. Jenkins, and N.L. Scholz. 2007. A Sensory System at the Interface Between Urban Stormwater Runoff and Salmon Survival. Environmental Science and Technology 41(8):2998–3004.

Scheuerell, M.D., and J.G. Williams. 2005. Forecasting climate-induced changes in the survival of Snake River spring/summer Chinook salmon (*Oncorhynchus tshawytscha*). Fisheries Oceanography 14:448-457.

Schnabel, J. 2019. unpublished data. Surface Water Data for Dissolved Copper and Zinc from Lower Basin Tributary Streams of the East Fork Lewis River. Provided by Jeff Schnabel, Stormwater Infrastructure Manager, Clark County Public Works, January 14, 2019.

Sen, S., and J. Roesler. 2017. Microscale heat island characterization of rigid pavements. Transportation Reseach Record. 2639:1 pp 73-83.

Sherwood, C.R., D.A. Jay, R.B. Harvey, P. Hamilton, and C.A. Simenstad. 1990. Historical changes in the Columbia River estuary. Progress in Oceanography 25(1-4):299-352.

Sprague, J.B. 1968. Avoidance reactions of rainbow trout to zinc sulphate solutions. Water Research. 2(5): 367-372.

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

Spromberg, J.A., and N.L. Scholz. 2011. Estimating future decline of wild coho salmon populations resulting from early spawner die-offs in urbanizing watersheds of the Pacific Northwest, USA. Integrated Environmental Assessment and Management 7(4):648-656.

Sunda, W. G., and W. J. Cai. 2012. Eutrophication induced CO2-acidification of subsurface coastal waters: interactive effects of temperature, salinity, and atmospheric p CO2. *Environmental Science & Technology*, 46(19): 10651-10659

Tague, C. L., Choate, J. S., & Grant, G. 2013. Parameterizing sub-surface drainage with geology to improve modeling streamflow responses to climate in data limited environments. *Hydrology and Earth System Sciences* 17(1): 341-354.

Takata TT. 2011. Oregon Lower Columbia River fall and winter Chinook spawning ground surveys 1952-2010. Oregon Department of Fish and Wildlife. Columbia River Managment. 22 p.

Tian, Z.; Zhao, H.; Peter, K.T.; Gonzalez, M.; Wetzel, J.; Wu, C.; Hu, X.; Prat, J.; Mudrock, E.; Hettinger, R.; et al. 2020. A ubiquitous tire rubber–derived chemical induces acute mortality in coho salmon. *Science*, 371, 185–189.

Tillmann, P., and D. Siemann. 2011. Climate Change Effects and Adaptation Approaches in Marine and Coastal Ecosystems of the North Pacific Landscape Conservation Cooperative Region. National Wildlife Federation.

Trudeau, M.P. 2017. State of the knowledge: Long-term, cumulative impacts of urban wastewater and stormwater on freshwater systems. Final Report Submitted to the Canadian Water Network. January 30, 2017.

USDC (U.S. Department of Commerce). 2011. Endangered and threatened species: Designation of critical habitat for the southern distinct population segment of eulachon. U.S. Department of Commerce, National Marine Fisheries Service. Federal Register 76(203):65324-65352.

Wadsworth, T. 2019. WDFW Monitoring and Management of Fish in the East Fork Lewis River. Washington Department of Fish and Wildlife, Region 5.

Wainwright, T. C., and L. A. Weitkamp. 2013. Effects of climate change on Oregon Coast coho salmon: habitat and life-cycle interactions. *Northwest Science* 87(3): 219-242.

WSDOT (Washington State Department of Transportation). 2020. Bridge Design Manual, M 23-50.20. WSDOT Bridge and Structures Office. September 2020. 1310 pp.

WSDOT. 2009. Wetland Response to Shade. Special study technical memorandum. 110 pp.

WDFW and ODFW. 2001. Joint state eulachon management plan. Washington Department of Fish and Wildlife and Oregon Department of Fish and Wildlife. Ecology Division. Santa Cruz, California.

Wheeler, A.P., P.L. Angermeier, and A.E. Rosenberger. 2005. Impacts of New Highways and Subsequent Landscape Urbanization on Stream Habitat and Biota. Reviews in Fisheries Science 13(3):141–164.

Winder, M. and D. E. Schindler. 2004. Climate change uncouples trophic interactions in an aquatic ecosystem. *Ecology* 85: 2100–2106.

Young, A., Kochenkov, V., McIntyre, J.K., Stark, J.D., and Coffin, A.B. 2018. Urban stormwater runoff negatively impacts lateral line development in larval zebrafish and salmon embryos. Scientific Reports 8: 2830.

Zabel, R.W., M.D. Scheuerell, M.M. McClure, and J.G. Williams. 2006. The interplay between climate variability and density dependence in the population viability of Chinook salmon. Conservation Biology 20(1):190-200.