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

Refer to NMFS No:
WCRO-2022-01443

September 25, 2023

William D. Abadie
Chief, Regulatory Branch
U.S. Army Corps of Engineers – Portland District
P.O. Box 2946
Portland, Oregon 97208-2946

Re: Endangered Species Act Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response for the Port of Longview Routine Repair & Maintenance Projects, Longview, Washington (NWP-2013-199-7)

Dear Mr. Abadie:

Thank you for your letter of June 15, 2022, requesting initiation of consultation with NOAA's National Marine Fisheries Service (NMFS) pursuant to section 7 of the Endangered Species Act of 1973 (ESA) (16 U.S.C. 1531 et seq.) for the U.S. Army Corps of Engineers' (USACE) authorization of the Port of Longview Routine Repair & Maintenance Projects.

NMFS also reviewed the likely effects of the proposed action on essential fish habitat (EFH), pursuant to section 305(b) of the Magnuson-Stevens Fishery Conservation and Management Act [16 U.S.C. 1855(b)], and concluded that the action would adversely affect the EFH of Pacific Coast Salmon. Therefore, we have included the results of that review in Section 3 of this document.

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

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

NMFS concurred with the USACE's determination that the proposed action is not likely to adversely affect the following species or their designated critical habitat:

- Southern DPS of green sturgeon (*Acipenser medirostris*)
- Southern Resident killer whale (*Orcinus orca*)

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

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

Please contact Sara Tilley in the Central Puget Sound Office in Lacey, Washington, at sara.m.tilley@noaa.gov if you have any questions concerning this consultation, or if you require additional information.

Sincerely,

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

cc: Kinsey Friesen, USACE

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

Port of Longview Routine Repair and Maintenance Projects (NWP-2013-199-7)

NMFS Consultation Number: WCRO-2022-01443

Action Agency: U.S. Army Corps of Engineers – Portland District

Affected Species and NMFS' Determinations:

ESA-Listed Species	Status	Is Action Likely to Adversely Affect Species?	Is Action Likely to Jeopardize the Species?	Is Action Likely to Adversely Affect Critical Habitat?	Is Action Likely to Destroy or Adversely Modify Critical Habitat?
Lower Columbia River Chinook salmon (*Oncorhynchus tshawytscha*)	Threatened	Yes	No	Yes	No
Upper Columbia River spring-run Chinook salmon	Endangered	Yes	No	Yes	No
Upper Willamette River spring-run Chinook salmon	Threatened	Yes	No	Yes	No
Snake River spring/summer-run Chinook salmon	Threatened	Yes	No	Yes	No
Snake River fall-run Chinook salmon	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
SR Sockeye salmon (*O. nerka*)	Endangered	Yes	No	Yes	No
Lower Columbia River steelhead (*O. mykiss*)	Threatened	Yes	No	Yes	No
Upper Willamette River steelhead	Threatened	Yes	No	Yes	No
Middle Columbia River steelhead	Threatened	Yes	No	Yes	No
Upper Columbia River steelhead	Threatened	Yes	No	Yes	No
Snake River Basin steelhead	Threatened	Yes	No	Yes	No
Southern DPS of Pacific eulachon (*Thaelichthys pacificus*)	Threatened	Yes	No	Yes	No
Southern DPS of green sturgeon (*Acipenser medirostris*)	Threatened	No	No	No	No
Southern Resident killer whale (*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: September 25, 2023

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1. INTRODUCTION

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

1.1. Background

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

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

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

1.2. Consultation History

This opinion is in response to the U.S. Army Corps of Engineers – Portland District (USACE) requesting formal consultation on their proposed authorization of the Port of Longview routine repair and maintenance projects. The affected ESA listed species are detailed in Table 1, below. The proposed repair and maintenance projects affect all these listed salmon and steelhead along with their critical habitat. The USACE also requested consultation on EFH for Pacific Coast salmon and an effects analysis will be provided in Section 3.

NMFS received the request for formal section 7 and EFH consultation along with a memorandum for the service and a biological assessment (BA) on June 15, 2022. The USACE's effects determination was likely to adversely affect (LAA) for most species. The determination for the Southern DPS of green sturgeon was not likely to adversely affect (NLAA).

- On September 22, 2022, NMFS requested more information for the missing project figures.
- On January 30, 2023, USACE requested an update on the project.
- On February 13, 2023, NMFS initiated the consultation process.
- On March 22, 2023, NMFS requested information on the additional proposed in-water work window outside the agency approved window.
- On May 8, 2023, NMFS requested information on the yearly vessel traffic at the Port's berths.

- On May 26, 2023, NMFS attended a meeting with the Port of Longview to clarify the reason for our request for vessel traffic information.
- On July 19, 2023, NMFS met with the Port to clarify questions on the terms and conditions and the expected yearly vessel traffic at the Port. They also considered conducting the maintenance actions under the SLOPES programmatic.
- On July 25, 2023, the Port confirmed that they would prefer to continue with the finalization of the formal consultation with NMFS rather than proceed under SLOPES.
- On August 4, 2023, NMFS met with the USACE to clarify terms and conditions for the proposed action.

Table 1. List of species included in this consultation for the Port of Longview Repair and Maintenance projects.

ESU or DPS Species	Listing Status	Listing Notice	Critical Habitat Listing
LCR[a] Chinook salmon	Threatened	6/28/2005; 70 FR 37160	9/2/2005; 70 FR 52630
UWR[a] Chinook salmon	Threatened	6/28/2005; 70 FR 37160	9/2/2005; 70 FR 52630
UCR[a] spring-run Chinook salmon	Endangered	6/28/2005; 70 FR 37160	9/2/2005; 70 FR 52630
SR[a] spring/summer-run Chinook salmon	Threatened	6/28/2005; 70 FR 37160	10/25/1999; 64 FR 57399
SR fall-run Chinook salmon	Threatened	6/28/2005; 70 FR 37160	10/25/1999; 64 FR 57399
CR[a] chum salmon	Threatened	6/28/2005; 70 FR 37160	9/2/2005; 70 FR 52630
LCR coho salmon	Threatened	6/28/2005; 70 FR 37160	2/24/2016; 81 FR 9252
SR sockeye salmon	Endangered	4/14/2014; 79 FR 20802	12/28/1993; 58 FR 68543
LCR steelhead	Threatened	1/5/2006; 71 FR 834	9/2/2005; 70 FR 52630
UWR steelhead	Threatened	1/5/2006; 71 FR 834	9/2/2005; 70 FR 52630
MCR[a] steelhead	Threatened	1/5/2006; 71 FR 834	9/2/2005; 70 FR 52630
UCR steelhead	Threatened	1/5/2006; 71 FR 834	9/2/2005; 70 FR 52630
SRB[a] steelhead	Threatened	1/5/2006; 71 FR 834	9/2/2005; 70 FR 52630
Southern DPS of Pacific eulachon	Threatened	3/18/2010; 75 FR 13012	10/20/2011; 76 FR 65324
Southern DPS of green sturgeon	Threatened	4/7/2006; 71 FR 17757	10/9/2009; 74 FR 52300
Southern Resident killer whale	Endangered	1/24/2008; 73 FR 4176	8/02/2021; 71 FR 69054

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

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

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

1.3. Proposed Federal Action

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

The USACE proposes to issue a permit to the Port of Longview (Port) to conduct multiple maintenance and repair projects at the Port's Berths 1 through 9 (Berths) and the Willow Grove Park boat launch and boat basin (Willow Grove) in Cowlitz County, Washington (Figure 1). This permit would replace two existing permits which establish the Port's maintenance program: a permit for fender pile replacement (NWP-2013-199/5) and a permit for miscellaneous repairs at the Port's facilities (NWP-2013-199/6). The Corps is proposing to include all of these maintenance activities into one permit to cover the next 4-year period. The project activities would occur year-round over a 4-year period with seasonal restrictions established for in-water activities. The Berths and Willow Grove are located along the mainstem Columbia River (CR) at river miles (RM) 66 to 67.5 and RM 58 respectively. Maintenance activities at the Berths would include the following actions: dock structure maintenance, fender pile replacement, bank stabilization, boathouse maintenance, miscellaneous maintenance above the original high-water mark (OHWM), woody debris removal & boom maintenance, and maintenance of the private aid to navigation (PATON). Maintenance activities at Willow Grove would include miscellaneous maintenance and repair below the OHWM; and miscellaneous maintenance and repair within 200 feet of the OHWM.

The eight berths (there is no Berth 3) provide important shipping access in the Lower Columbia River (LCR), and accommodate large cargo ships for domestic and international transport of materials (Figure 2). The Port and its tenants primarily handle dry bulk, and breakbulk cargo at the Berths. Willow Grove comprises of several floating docks and is protected by a pile-supported concrete plank wall breakwater along with having several square feet of riprap stabilizing the shoreline (Figure 2). Willow Grove is an access point for the CR that is used for recreational boats and emergency response vessels.

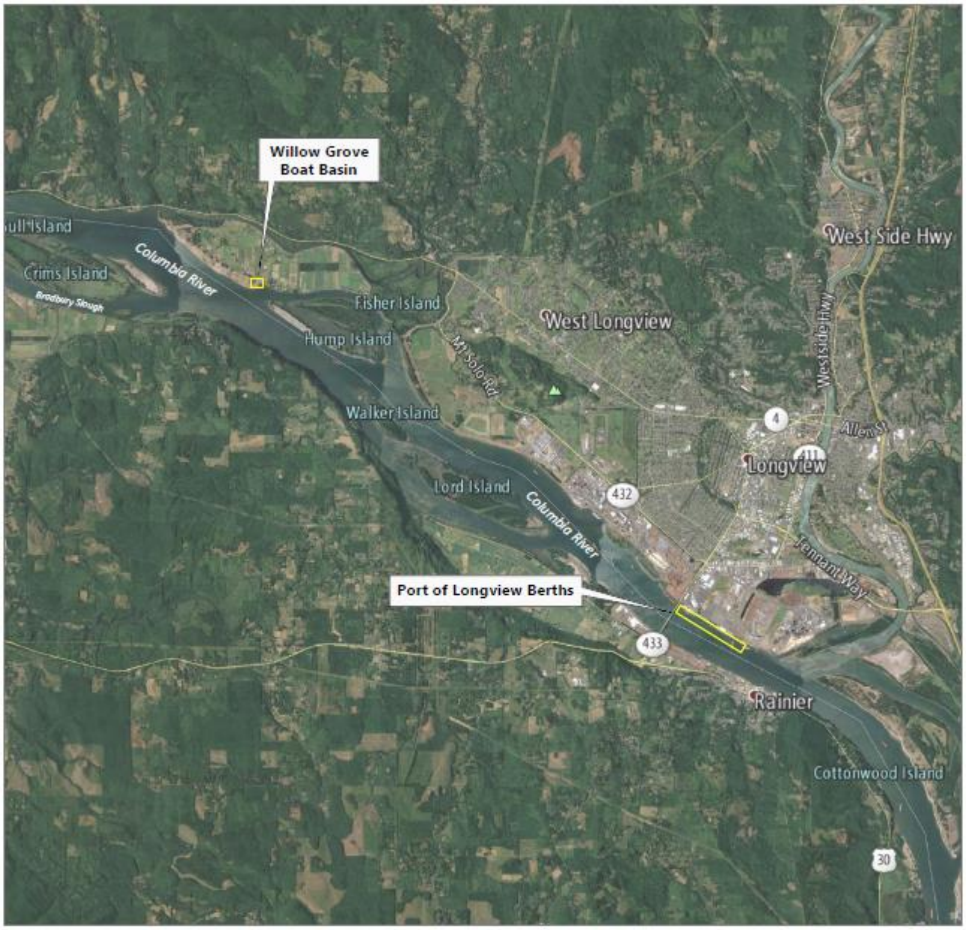

Figure 1. Port of Longview facilities in Longview, Washington. Figure courtesy of Anchor QEA, LLC.

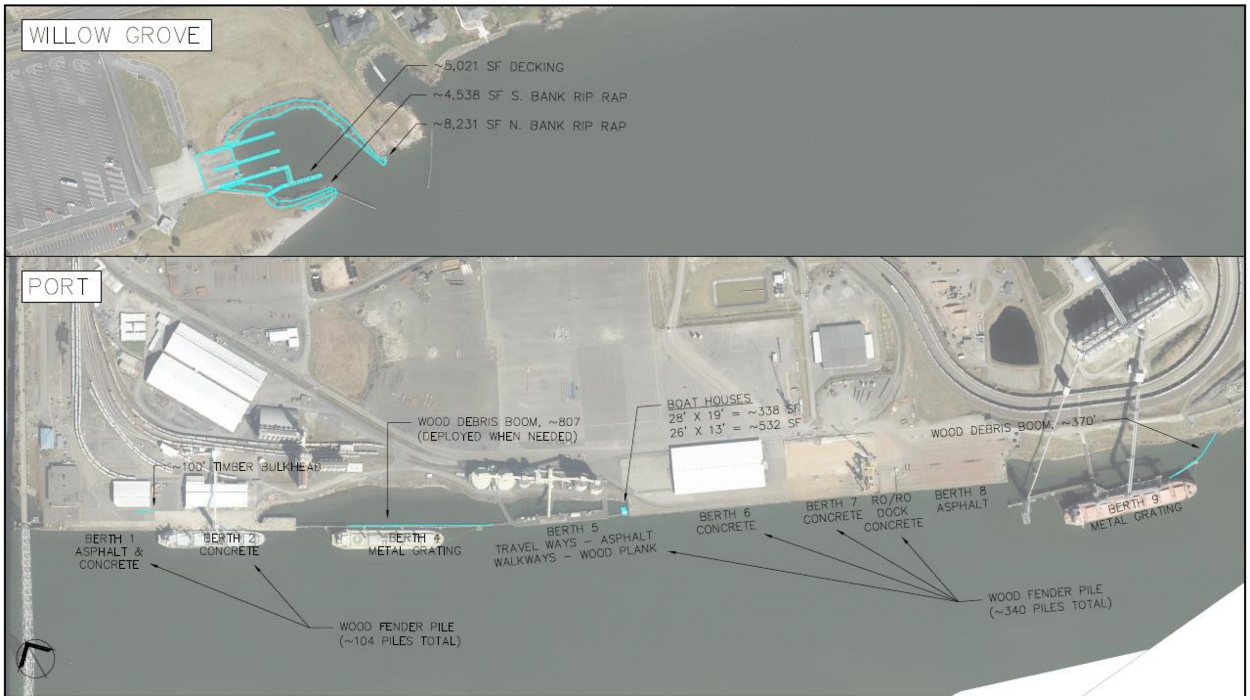

Figure 2. Willow Grove and Port of Longview Berths 1–9. Port of Longview facilities in Longview, Washington. Figure courtesy of Anchor QEA, LLC.

Maintenance & Repair at Berths 1–9

Dock Structure Maintenance

The proposed dock structure maintenance consists of the removal of deteriorating or damaged treated timbers located under the berth deck and along the bulkhead, and replacing them with new treated timbers. All work would occur in dry conditions above the water surface elevation.

Maintenance would occur at Berths 1, 2, 5, 6, 7, and the roll-on/roll-off (Ro-Ro) dock at Berth 7. All maintenance would be conducted by Port pile bucks working from varying platforms: walkways located under the Berths, the shore, floating platforms, the berth, or from a skiff. Posts would be removed by jacking up the bearing cap and making two saw cuts to the deteriorating or damaged post and then removing it. The new treated post would be installed in place in place of the old one and braced. Bearing caps would be removed and replaced in a similar fashion with the berth decking being jacked up instead of the bearing cap itself. Post and bearing cap timbers range in size from 12 inches x 12 inches x 20–22 feet in size to 14 inches x 14 inches x 20–22 feet in size. Longitudinal and cross bracing, girts, and other support timbers would be removed and replaced along with posts and bearing caps.

All removed timbers would be stored at an upland location for other Port operations, donated to mitigation projects, or hauled off-site to an appropriate disposal location. Displaced bulkhead backfill would either be replaced or transported to an upland location for other uses. The Port anticipates that no more than 200 timbers would be replaced from under the Berths in any given year.

Fender Pile Replacement

Fender pile replacement includes the removal and replacement of one or more untreated wood piles at the Berths. Damaged or deteriorated fender piles would be removed and replaced when necessary. Where possible, fender piles (12–16-inch in diameter untreated wooden piles) would be removed and replaced using a vibratory hammer. The vibratory hammer would be attached to a crane-mounted barge near the dock. During operation, the vibratory hammer would be clamped onto the pile and the crane would lift the vibratory hammer, pulling the pile from the sediment and out of the water. Typically, the hammer would vibrate for less than 1 minute per pile during removal. As a result, no more than a few minutes of hammer vibration would occur for each pile removed. If a pile breaks during removal, a chain would be used to remove the pile entirely. If the pile cannot be removed, it would be cut at the mudline.

Pile installation would take roughly the same amount of time as pile removal, given that the piles would be replaced approximately in the same locations. The installation of new piles in place of the old ones would be prioritized to reduce the area of substrate being disturbed. Installation would involve placing a choker around the pile and setting it in place at the midline. The vibratory hammer would be attached to the pile and vibrate the pile to the required elevation. Proofing with an impact hammer would not be necessary due to the soft substrate in the area.

Bank Stabilization

Proposed bank stabilization activities include the replacement of riprap and timber bulkheads beneath existing dock structures to stabilize the shoreline, and placement of up to 500 cubic yards of additional riprap. No more than 1,000 linear feet of bulkhead in any given year would be replaced under this permit. Equipment consists of a long-armed excavator and/or crane and work would occur from the shoreline, through a temporary opening in the dock, or a barge. Soil would be stabilized fully prior to the project area contacting water.

Temporary excavation for bulkhead repair would occur at Berths 1 and 2. A long-armed excavator would remove riprap and the untreated timber bulkhead; then, replace the timber bulkhead and riprap with removed material and up to 500 cubic yards of additional clean 2 to 4-man riprap. Timbers used for bank stabilization purposes are typically 4 x 12 inches in size with a wide range of lengths depending on the application. All timbers would be connected using galvanized pins, bolts, brackets, and other hardware. Bank stabilization work would occur above and below the OHWM but would not contact the wetted perimeter of the river. The riprap would only be placed as backfill behind the timber bulkhead. No more than 1,000 linear feet of bulkhead would be replaced per year, for a total of up to 4,000 linear feet of bulkhead replacement.

Boathouse Maintenance

Proposed boathouse maintenance activities include the replacement of decking with grated decking and floats with plastic enclosed floats; and housing, mooring and utilities maintenance. Utilities maintenance includes painting, welding, and carpentry. Maintenance of the two boathouses would occur using standard construction practices. Work would occur from the boathouse structure or from a skiff.

Miscellaneous Maintenance Above the OHWM

Proposed miscellaneous maintenance and repair work would be conducted above the OHWM but may be conducted on top of and/or below the berth decks, and along the shoreline. Work includes structural and non-structural maintenance and repair activities to keep the Berths, outfalls, and other infrastructure in working order. Above-deck work includes but is not limited to resurfacing of roadways and docks; crack sealing; pothole patching; replacement of stormwater sumps, catch basins, and other stormwater infrastructure; building and facilities maintenance (painting, reroofing, window and door replacement, gutters, etc.); maintenance of bull rails, bollards, and capstans; rail line repairs; and repairs to other Port infrastructure. Below deck work includes but is not limited to the maintenance of stormwater and effluent infrastructure (Berths 2, 5, 6, and 7), lighting, plumbing, sprinklers, electrical and communication lines, and other Port infrastructure. Shoreline work includes outfall repair and invasive weed removal above the OHWM.

Woody Debris Removal and Boom Maintenance

The Berths entrap woody debris as it floats down the CR. This can be detrimental to the structural integrity of the berth structures. For this action, Port staff would move the debris back into the channel using a skiff. Additionally, a debris boom would be maintained as needed at Berth 4 and Berth 9 to reduce the volume of accumulated debris. The entrapped debris is pushed/pulled back out into the main channel when debris accumulation becomes a structural concern. The debris booms located at Berth 4 and Berth 9 help to reduce the amount of debris accumulating at these locations and would be maintained throughout the year. The debris boom would be maintained with untreated timber or would be replaced with a plastic-coated alternative.

PATON Maintenance

The Port would perform maintenance to the PATON located at Berth 9. Minor maintenance and repairs would be conducted from the berth deck.

Willow Grove Maintenance & Repair

Maintenance Activities Below OHWM

Maintenance activities would include the following:

- Replacing structural elements on the floating docks including floats, boards/planks, railings, and bull rails;
- Patching concrete on the boat launch ramp above the wetted perimeter;
- Painting overwater structures;
- Maintaining breakwater structures;
- Maintaining utilities located on floating structures;
- Clearing floating debris from the boat launch (floating debris would be removed from the boat launch and disposed of at an upland location); and
- Maintaining the debris boom including replacement of portions of the boom as needed.

All work would be conducted within the existing float, ramp, or riprap structures. A small floating barge may also be used to place materials for maintenance and would be tethered to the docks during the work period. The replacement of any existing infrastructure would be designed to reduce in-water and habitat impacts. Maintenance below and over the OHWM would be conducted year-round in dry conditions and in-water work would occur during the agency-approved in-water work window (IWWW). Riprap may be replaced using a long-armed excavator from an upland location. Maintenance or replacement activities would use less impactful materials, such as decking materials that reduce overwater shading and uncured concrete would not contact water during ramp patching.

Maintenance Activities Within 200 Feet of OHWM

Maintenance activities would include the replacing of pathway aggregate; and repairing and maintaining the picnic building, park overlook, benches, signs, park lighting and other amenities. Most of the proposed work is expected to be completed with the use of various small equipment and hand tools such as shovels, handheld power drills, pathway aggregate spreaders, and other small equipment.

Best Management Practices (BMP) related to Maintenance and Repair Activities

General Construction BMPs

- Approximately 95% of the support timbers to be removed and replaced would have a portion of the member located below the OHWM; however, all work would occur in dry (i.e., below the water surface elevation) conditions.
- A containment boom would be placed around the work area to confine sawdust dispersal. Work would be scheduled to coincide with environmental conditions (river flows, tides, etc.) such that work would be performed in dry conditions.
- Port pile bucks would follow the Port Spill Prevention, Control, and Countermeasure (SPCC) Plan, which requires notification to the environmental department in the event of a spill. If a spill does occur upland or in water, the Port has spill kits and containment booms readily available for emergency cleanup/containment.
- All treated wood posts and timbers would be treated with Ammoniacal Copper Zinc Arsenate (ACZA), also known as Chemonite. Treated posts and timbers would be treated by the manufacturer and handled by the Port in a manner that would meet or exceed the standards established in "Best Management Practices: For the Use of Treated Wood in Aquatic and Other Sensitive Environments," developed by the Western Wood Preservers Institute, revised August 2006.
- Contractors conducting in-water and overwater work would be skilled and familiar with implemented BMPs and permit conditions typical of working in the aquatic environment.
- Typical construction BMPs to ensure that debris materials do not enter the water and or stormwater.
- Drain covers, socks, berms, and/or in-water containment booms would be employed as appropriate to minimize water quality impacts.
- All excess materials and debris would be removed after completion of work and the work area would be returned to its previous condition.

Fender Pile Replacement BMPs

- All workers would follow the Port's SPCC Plan to be used for the duration of the project to safeguard against an unintentional release of fuel, lubricants, or hydraulic fluid from construction equipment.
- Pile removal BMPs adapted from USEPA (2007) and a NMFS (2008) would be employed for removal of the untreated wooden fender piles and include the following:
    - The contractor would initially vibrate the pile to break the friction bond between pile and substrate.
    - To help minimize turbidity, the contractor would engage the vibrator to the minimum extent required to initiate vertical pile movement and would disengage the vibratory hammer once the pile has been mobilized and is moving upward.
    - The piles would be removed in a single, slow, and continuous motion to the best extent possible.
    - Pile cutoff would be an acceptable alternative where vibratory extraction or pulling is not feasible. In addition, if a pile is broken or breaks during vibratory extraction, the contractor would employ the following methods:
        - A chain would be used if practicable to attempt to entirely remove the broken pile.
        - If the entire pile cannot be removed, the pile would be cut at the mudline.
    - Upon removal from the substrate, the pile would be moved expeditiously from the water to a barge, and then offloaded for disposal or recycled for use in Port operations or mitigation projects if possible.
    - Replacement fender piles would be in-kind, as noted previously.

Bank Stabilization BMPs

- The extent of riprap replacement would be limited to those areas within the existing riprap footprint.
- Replacement riprap shall consist of similar type and sizes to current conditions and that contain no fines, soils, or other wastes or contaminants.
- Drain covers, socks, berms, and/or in-water containment booms would be employed as appropriate to minimize water quality impacts.

We considered, under the ESA, whether or not the proposed action would cause any other activities and determined that it would cause the following activities: commercial vessel traffic at the Berths, recreational and emergency vessel traffic at Willow Grove and the extended life of these dock and shoreline armoring structures. Without the proposed action, vessels would not be able to continue to use these facilities. Consequently, the vessel traffic is caused by the proposed action. Many of the piles and structures to be maintained and replaced are needed to maintain the structural integrity of the Berths and for the safe continuous public use of Willow Grove.

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

1.4. Action Area

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

The proposed action area consists of the Berths (RM 66 to 67.5), Willow Grove Park (RM 58) and the adjacent sections of the CR that would be affected by the proposed repair and maintenance activities. The upriver extent of the action area is defined by the distance from the point where vibratory installation/removal of piles exceeds 120 dB_{RMS} (i.e., the square root of the mean square of a single impulse pressure event, measured in decibels [dB]) (Anchor QEA, 2022). The approximate attenuation sound radius is 0.62 miles from the point of disturbance however, the actual area of increased underwater sound would be constrained by the shorelines of the CR (Anchor QEA, 2022). This distance was calculated using the Practical Spreading Loss model provided in the BA. The downriver extent of the action area is the mouth of the CR. This approximation reflects the effects of wake stranding from ocean going vessel (OGV) traffic. This also reflects the potential for long period wake wave stranding of juvenile salmonids on certain beaches distributed upstream of the mouth of the CR to the Berths.

The action area is within designated critical habitat, providing a migration corridor and foraging habitat for most species listed in Table 1 above. The action area also contains EFH for Pacific Coast salmon which will be explained further in Section 3 of this opinion. Although the project activities at the Port's facilities do not fall within designated critical habitat for the Southern DPS of green sturgeon, the downriver effects of the action do occur within designated critical habitat for this species. These effects are discussed further in Section 2.11 of this opinion.

2. ENDANGERED SPECIES ACT BIOLOGICAL OPINION AND INCIDENTAL TAKE STATEMENT

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

The USACE determined the proposed action is not likely to adversely affect the Southern DPS of green sturgeon or its critical habitat. Our concurrence with this determination and our analysis of the Southern Resident killer whale (SRKW) is documented in the "Not Likely to Adversely Affect" Determinations section (Section 2.11).

2.1. Analytical Approach

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

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

The designations of critical habitat for LCR Chinook salmon, UWR Chinook salmon, UCR spring-run Chinook salmon, SR spring/summer-run Chinook salmon, SR fall-run Chinook salmon, LCR coho salmon, SR sockeye salmon, CR chum salmon, LCR steelhead, UWR steelhead, MCR steelhead, UCR steelhead, SR steelhead, the Southern DPS of Pacific eulachon, the Southern DPS of green sturgeon, and the SRKW use the term primary constituent element (PCE) or essential features. The 2016 final rule (81 FR 7414; February 11, 2016) that revised the critical habitat regulations (50 CFR 424.12) replaced this term with physical or biological features (PBFs). The shift in terminology does not change the approach used in conducting a “destruction or adverse modification” analysis, which is the same regardless of whether the original designation identified PCEs, PBFs, or essential features. In this biological opinion, we use the term PBF to mean PCE or essential feature, as appropriate for the specific critical habitat.

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

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

- Evaluate the range-wide status of the species and critical habitat expected to be adversely affected by the proposed action.
- Evaluate the environmental baseline of the species and critical habitat.
- Evaluate the effects of the proposed action on species and their critical habitat using an exposure–response approach.
- Evaluate cumulative effects.
- In the integration and synthesis, add the effects of the action and cumulative effects to the environmental baseline, and, in light of the status of the species and critical habitat, analyze whether the proposed action is likely to: (1) directly or indirectly reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species; or (2) directly or

indirectly result in an alteration that appreciably diminishes the value of critical habitat as a whole for the conservation of a listed species.

- If necessary, suggest a reasonable and prudent alternative to the proposed action.

2.2. Range-wide Status of the Species and Critical Habitat

This opinion examines the status of each species that is likely to be adversely affected by the proposed action. The status is determined by the level of extinction risk that the listed species face, based on parameters considered in documents such as recovery plans, status reviews, and listing decisions. This informs the description of the species' likelihood of both survival and recovery. The species status section also helps to inform the description of the species' "reproduction, numbers, or distribution" for the jeopardy analysis. The opinion also examines the condition of 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 area. Major ecological realignments are already occurring in response to climate change (IPCC WGII, 2022). Long-term trends in warming have continued at global, national and regional scales. Global surface temperatures in the last decade (2010's) were estimated to be 1.09 °C higher than the 1850–1900 baseline period, with larger increases over land ~1.6 °C compared to oceans ~0.88 (IPCC WGI, 2021). Much of this warming has been attributed to anthropogenic releases of greenhouse gases (IPCC WGI, 2021). Globally, 2014–2018 were the 5 warmest years on record both on land and in the ocean (2018 was the 4th warmest) (NOAA NCEI, 2022). Events such as the 2013–2016 marine heatwave have been attributed directly to anthropogenic warming in the annual special issue of "Bulletin of the American Meteorological Society" on extreme events (Herring et al., 2018; Jacox et al., 2018). Global warming and anthropogenic loss of biodiversity represent profound threats to ecosystem functionality (IPCC WGII, 2022). These two factors are often examined in isolation, but likely have interacting effects on ecosystem function.

Updated projections of climate change are similar to or greater than previous projections (IPCC WGI, 2021). NMFS is increasingly confident in our projections of changes to freshwater and marine systems because every year brings stronger validation of previous predictions in both physical and biological realms. Retaining and restoring habitat complexity, access to climate refuges (both flow and temperature) and improving growth opportunity in both freshwater and marine environments are strongly advocated in the recent literature (Siegel & Crozier, 2020). Climate change is systemic, influencing freshwater, estuarine, and marine conditions. Other systems are also being influenced by changing climatic conditions. Literature reviews on the impacts of climate change on Pacific salmon have collected hundreds of papers documenting the major themes relevant for salmon (Crozier, 2015, 2016, 2017; Crozier & Siegel, 2018; Siegel & Crozier, 2019, 2020). Here we describe habitat changes relevant to Pacific salmon and steelhead, prior to describing how these changes result in the varied specific mechanisms impacting these species in subsequent sections.

Forests

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

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

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

Freshwater Environments

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

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

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

As cited in Siegel and Crozier (2019), Isaak et al. (2018), examined recent trends in stream temperature across the Western U.S. using a large regional dataset. Stream warming trends paralleled changes in air temperature and were pervasive during the low-water warm seasons of 1996–2015 (0.18–0.35°C/decade) and 1976–2015 (0.14–0.27°C/decade). Their results show how continued warming will likely affect the cumulative temperature exposure of migrating sockeye salmon (*O. nerka*) and the availability of suitable habitat for brown trout (*Salmo trutta*) and rainbow trout (*O. mykiss*). Isaak et al. (2018) concluded that most stream habitats will likely remain suitable for salmonids in the near future, with some becoming too warm. However, in cases where habitat access is currently restricted by dams and other barriers salmon and steelhead will be confined to downstream reaches typically most at risk of rising temperatures unless passage is restored (FitzGerald et al., 2021; Myers et al., 2018).

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

Marine and Estuarine Environments

Along with warming stream temperatures and concerns about enough groundwater to recharge streams, a recent study projects nearly complete loss of existing tidal wetlands along the U.S. West Coast, due to sea level rise (Thorne et al., 2018). California and Oregon showed the greatest threat to tidal wetlands (100%), while 68% of Washington tidal wetlands are expected to be submerged. Coastal development and steep topography prevent horizontal migration of most wetlands, causing the net contraction of this crucial habitat.

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

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

Climate change effects on salmon and steelhead

In freshwater, year-round increases in stream temperature and changes in flow will affect physiological, behavioral, and demographic processes in salmon, and change the species with which they interact. For example, as stream temperatures increase, many native salmonids face increased competition with more warm-water tolerant invasive species. Changing freshwater temperatures are likely to affect incubation and emergence timing for eggs, and locations where the greatest warming occurs may affect egg survival. Although, several factors impact inter-gravel temperature and oxygen (e.g., groundwater influence) as well as sensitivity of eggs to thermal stress (Crozier et al., 2020). Changes in temperature and flow regimes may alter the amount of habitat and food available for juvenile rearing, and this in turn could lead to a restriction in the distribution of juveniles, further decreasing productivity through density dependence. For migrating adults, predicted changes in freshwater flows and temperatures will likely increase exposure to stressful temperatures for many salmon and steelhead populations, and alter migration travel times and increase thermal stress accumulation for ESUs or DPSs with early-returning (i.e. spring and summer-run) phenotypes associated with longer freshwater holding times (Crozier et al., 2020; FitzGerald et al., 2021). Rising river temperatures increase the energetic cost of migration and the risk of en route or pre-spawning mortality of adults with long freshwater migrations, although populations of some ESA-listed salmon and steelhead may be able to make use of cool-water refuges and run-timing plasticity to reduce thermal exposure (Keefer et al., 2018; Barnett et al., 2020).

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

Synchrony between terrestrial and marine environmental conditions (e.g., coastal upwelling, precipitation and river discharge) has increased in spatial scale causing the highest levels of synchrony in the last 250 years (Black et al., 2018). A more synchronized climate combined with simplified habitats and reduced genetic diversity may be leading to more synchrony in the productivity of populations across the range of salmon (Braun et al., 2016). For example, salmon productivity (recruits/spawner) has also become more synchronized across Chinook populations from Oregon to the Yukon (Dorner et al., 2018; Kilduff et al., 2014). In addition, Chinook salmon have become smaller and younger at maturation across their range (Ohlberger, 2018). Other Pacific salmon species and Atlantic salmon also have demonstrated synchrony in productivity across a broad latitudinal range (Stachura el al., 2014; Olmos et al., 2020).
At the individual scale, climate impacts on salmon in one life stage generally affect body size or timing in the next life stage and negative impacts can accumulate across multiple life stages (Healey, 2011; Wainwright & Weitkamp, 2013; Gosselin et al., 2021). Changes in winter precipitation will likely affect incubation and/or rearing stages of most populations. Changes in the intensity of cool season precipitation, snow accumulation, and runoff could influence migration cues for fall, winter and spring adult migrants, such as coho and steelhead. Egg survival rates may suffer from more intense flooding that scours or buries redds. Changes in hydrological regime, such as a shift from mostly snow to more rain, could drive changes in life history, potentially threatening diversity within an ESU (Beechie et al., 2006). Changes in summer temperature and flow will affect both juvenile and adult stages in some populations, especially those with yearling life histories and summer migration patterns (Crozier & Zabel, 2006; Crozier et al., 2010, 2019).

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

2.2.1 Status of the Species

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

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

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

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

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

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

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

Species	**Listing Classification and Date**	**Recovery Plan Reference**	**Most Recent Status Review**	**Status Summary**	**Limiting Factors**
SRB steelhead	Threatened 1/05/06	(NMFS, 2017a)	(NMFS 2022i; Ford, 2022)	This DPS comprises 24 populations. Based on the updated viability information available for this review, all five MPGs are not meeting the specific objectives in the draft recovery plan, and the viability of many individual populations remains uncertain. Of particular note, the updated, population-level abundance estimates have made very clear the recent (last five years) sharp declines that are extremely worrisome, were they to continue.	• Adverse effects related to the mainstem CR hydropower system. • Impaired tributary fish passage. • Degraded freshwater habitat. • Increased water temperature. • Harvest-related effects, particularly for B-run steelhead. • Predation • Genetic diversity effects from out-of-population hatchery releases.
Southern DPS of Pacific eulachon	Threatened 3/18/10	(NMFS, 2017c)	(NMFS, 2022j)	The Southern DPS of eulachon includes all naturally-spawned populations that occur in rivers south of the Nass River in British Columbia to the Mad River in California. Sub populations for this species include the Fraser River, CR, British Columbia and the Klamath River. In the early 1990s, there was an abrupt decline in the abundance of eulachon returning to the CR. Despite a brief period of improved returns in 2001–2003, the returns and associated commercial landings eventually declined to the low levels observed in the mid-1990s. Although eulachon abundance in monitored rivers has generally improved, especially in the 2013–2015 return years, recent poor ocean conditions and the likelihood that these conditions will persist into the near future suggest that population declines may be widespread in the upcoming return years.	• Changes in ocean conditions due to climate change, particularly in the southern portion of the species' range where ocean warming trends may be the most pronounced and may alter prey, spawning, and rearing success. • Climate-induced change to freshwater habitats. • Bycatch of eulachon in commercial fisheries. • Adverse effects related to dams and water diversions. • Water quality • Shoreline construction • Over harvest • Predation

2.2.2 Status of the Critical Habitat

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

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

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

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

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

Species	**Designation Date and Federal Register Citation**	**Critical Habitat Status Summary**
LCR Chinook salmon	9/02/05 70 FR 52630	Critical habitat encompasses 10 sub-basins in Oregon and Washington containing 47 occupied watersheds, as well as the lower CR rearing/migration corridor. Most HUC5 watersheds with PCEs for salmon are in fair-to-poor or fair-to-good condition (NMFS, 2005). However, most of these watersheds have some, or high potential for improvement. We rated conservation value of HUC5 watersheds as high for 30 watersheds, medium for 13 watersheds, and low for four watersheds.
UCR spring-run Chinook salmon	9/02/05 70 FR 52630	Critical habitat encompasses four sub-basins in Washington containing 15 occupied watersheds, as well as the CR rearing/migration corridor. Most HUC5 watersheds with PCEs for salmon are in fair-to-poor or fair-to-good condition. However, most of these watersheds have some, or high, potential for improvement. We rated conservation value of HUC5 watersheds as high for 10 watersheds, and medium for five watersheds. Migratory habitat quality in this area has been severely affected by the development and operation of the dams and reservoirs of the Federal Columbia River Power System.
SR spring/summer-run Chinook salmon	10/25/99 64 FR 57399	Critical habitat consists of river reaches of the Columbia, Snake, and Salmon rivers, and all tributaries of the Snake and Salmon rivers (except the Clearwater River) presently or historically accessible to this ESU (except reaches above impassable natural falls and Hells Canyon Dam). Habitat quality in tributary streams varies from excellent in wilderness and roadless areas, to poor in areas subject to heavy agricultural and urban development (Wissmar et al., 1994). Reduced summer stream flows, impaired water quality, and reduced habitat complexity are common problems. Migratory habitat quality in this area has been severely affected by the development and operation of the dams and reservoirs of the Federal Columbia River Power System.
SR fall-run Chinook salmon	10/25/99 64 FR 57399	Critical habitat consists of river reaches of the Columbia, Snake, and Salmon rivers, and all tributaries of the Snake and Salmon rivers presently or historically accessible to this ESU (except reaches above impassable natural falls, and Dworshak and Hells Canyon dams). Habitat quality in tributary streams varies from excellent in wilderness and roadless areas, to poor in areas subject to heavy agricultural and urban development (Wissmar et al., 1994). Reduced summer stream flows, impaired water quality, and reduced habitat complexity are common problems. Migratory habitat quality in this area has been severely affected by the development and operation of the dams and reservoirs of the Federal Columbia River Power System.

Species	**Designation Date and Federal Register Citation**	**Critical Habitat Status Summary**
UWR Chinook salmon	9/02/05 70 FR 52630	Critical habitat encompasses 10 sub-basins in Oregon containing 56 occupied watersheds, as well as the lower Willamette/Columbia River rearing/migration corridor. Most HUC5 watersheds with PCEs for salmon are in fair-to-poor or fair-to-good condition. However, most of these watersheds have some, or high, potential for improvement. Watersheds are in good to excellent condition with no potential for improvement only in the upper McKenzie River and its tributaries (NMFS, 2005). We rated conservation value of HUC5 watersheds as high for 22 watersheds, medium for 16 watersheds, and low for 18 watersheds.
CR chum salmon	9/02/05 70 FR 52630	Critical habitat encompasses six sub-basins in Oregon and Washington containing 19 occupied watersheds, as well as the LCR rearing/migration corridor. Most HUC5 watersheds with PCEs for salmon are in fair-to-poor or fair-to-good condition (NMFS, 2005). However, most of these watersheds have some or a high potential for improvement. We rated conservation value of HUC5 watersheds as high for 16 watersheds, and medium for three watersheds.
LCR coho salmon	2/24/16 81 FR 9252	Critical habitat encompasses 10 sub-basins in Oregon and Washington containing 55 occupied watersheds, as well as the LCR and estuary rearing/migration corridor. Most HUC5 watersheds with PCEs for salmon are in fair-to-poor or fair-to-good condition (NMFS, 2005). However, most of these watersheds have some or a high potential for improvement. We rated conservation value of HUC5 watersheds as high for 34 watersheds, medium for 18 watersheds, and low for three watersheds.
SR sockeye salmon	10/25/99 64 FR 57399	Critical habitat consists of river reaches of the Columbia, Snake, and Salmon rivers; Alturas Lake Creek; Valley Creek; and Stanley, Redfish, Yellow Belly, Pettit and Alturas lakes (including their inlet and outlet creeks). Water quality in all five lakes generally is adequate for juvenile sockeye salmon, although zooplankton numbers vary considerably. Some reaches of the Salmon River and tributaries exhibit temporary elevated water temperatures and sediment loads that could restrict sockeye salmon production and survival (NMFS, 2015). Migratory habitat quality in this area has been severely affected by the development and operation of the dams and reservoirs of the Federal Columbia River Power System.
UCR steelhead	9/02/05 70 FR 52630	Critical habitat encompasses 10 sub-basins in Washington containing 31 occupied watersheds, as well as the CR rearing/migration corridor. Most HUC5 watersheds with PCEs for salmon are in fair-to-poor or fair-to-good condition (NMFS, 2005). However, most of these watersheds have some or a high potential for improvement. We rated conservation value of HUC5 watersheds as high for 20 watersheds, medium for eight watersheds, and low for three watersheds.

Species	**Designation Date and Federal Register Citation**	**Critical Habitat Status Summary**
LCR steelhead	9/02/05 70 FR 52630	Critical habitat encompasses nine sub-basins in Oregon and Washington containing 41 occupied watersheds, as well as the LCR rearing/migration corridor. Most HUC5 watersheds with PCEs for salmon are in fair-to-poor or fair-to-good condition (NMFS, 2005). However, most of these watersheds have some or a high potential for improvement. We rated conservation value of HUC5 watersheds as high for 28 watersheds, medium for 11 watersheds, and low for two watersheds.
UWR steelhead	9/02/05 70 FR 52630	Critical habitat encompasses seven sub-basins in Oregon containing 34 occupied watersheds, as well as the lower Willamette/Columbia River rearing/migration corridor. Most HUC5 watersheds with PCEs for salmon are in fair-to-poor or fair-to-good condition (NMFS, 2005). However, most of these watersheds have some or a high potential for improvement. Watersheds are in good to excellent condition with no potential for improvement only in the upper McKenzie River and its tributaries (NMFS, 2005). We rated conservation value of HUC5 watersheds as high for 25 watersheds, medium for 6 watersheds, and low for 3 watersheds.
MCR steelhead	9/02/05 70 FR 52630	Critical habitat encompasses 15 sub-basins in Oregon and Washington containing 111 occupied watersheds, as well as the CR rearing/migration corridor. Most HUC5 watersheds with PCEs for salmon are in fair-to-poor or fair-to-good condition (NMFS, 2005). However, most of these watersheds have some or a high potential for improvement. We rated conservation value of occupied HUC5 watersheds as high for 80 watersheds, medium for 24 watersheds, and low for 9 watersheds.
SRB steelhead	9/02/05 70 FR 52630	Critical habitat encompasses 25 sub-basins in Oregon, Washington, and Idaho. Habitat quality in tributary streams varies from excellent in wilderness and roadless areas, to poor in areas subject to heavy agricultural and urban development (Wissmar et al., 1994). Reduced summer stream flows, impaired water quality, and reduced habitat complexity are common problems. Migratory habitat quality in this area has been severely affected by the development and operation of the dams and reservoirs of the Federal Columbia River Power System.

Species	**Designation Date and Federal Register Citation**	**Critical Habitat Status Summary**
Southern DPS of Pacific eulachon	10/20/11 76 FR 65324	Critical habitat for eulachon includes portions of 16 rivers and streams in California, Oregon, and Washington. All these areas are designated as migration and spawning habitat for this species. In Oregon, we designated 24.2 miles of the lower Umpqua River, 12.4 miles of the lower Sandy River, and 0.2 miles of Tenmile Creek. We also designated the mainstem CR from the mouth to the base of Bonneville Dam, a distance of 143.2 miles. Dams and water diversions are moderate threats to eulachon in the Columbia and Klamath rivers where hydropower generation and flood control are major activities. Degraded water quality is common in some areas occupied by southern DPS eulachon. In the Columbia and Klamath river basins, large-scale impoundment of water has increased winter water temperatures, potentially altering the water temperature during eulachon spawning periods. Numerous chemical contaminants are also present in spawning rivers, but the exact effect these compounds have on spawning and egg development is unknown. Dredging is a low to moderate threat to eulachon in the CR. Dredging during eulachon spawning would be particularly detrimental.

2.3. Environmental Baseline

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

2.3.1 Habitat Conditions in the Action Area

The portion of the action area located at the Berths (RM 66–67.5) is in a highly industrial area of the CR and near the Old Mouth of the Cowlitz River. The portion at Willow Grove (RM 58) is surrounded by rural development characterized by residential and agricultural land use. The action area is influenced by the water and sediment quality, river flow, noise, prey communities, and riparian conditions typical of this section of the CR. Fish habitat in the action area has been adversely affected by a variety of in-water and upland human activities: habitat losses from all causes (urbanization, diking, roads, etc.); flood control systems; irrigation systems; hydroelectric dam presence; pollution; municipal and industrial water use; non-native/introduced species; fish hatchery production; and climate change (Dornbusch & Sihler, 2013). Some of these changes are described in Section 2.2. Analysis of historical habitat distributions using a Geographic Information System (GIS) indicated that scrub/shrub and forested wetland types have declined in the estuary since the late 19th and early 20th centuries by 55 and 58 percent, respectively. Diking, filling, and other changes have reduced the total area of all wetland types combined from approximately 155 to 75 square kilometers (Bottom et al., 2011).

Substrate: The Berths are located in relatively deep water ranging from -35 to -50 feet Columbia River Datum (CRD). The shoreline has characteristics of the typical industrial shoreline. The sediment texture and bedforms indicate the area is affected by fast currents that result in shifted sediments. Sediments in this portion of the CR contain a low percentage of fine sediment. Large asymmetrical sand waves more than 10 feet wide and 100 feet long occur along parts of the riverbed. Despite these conditions, shoaling fish are not uncommon due to the large sediment load introduced at the mouth of the Cowlitz River.

The shoreline at Willow Grove is armored with riprap and a groin to protect the basin from wind and waves to ensure safe launching and moorage of vessels. Shorelines in other parts of the Willow Grove Park are not armored and are characterized by white sandy beaches. The sediments found at Willow Grove are different when compared to usual sediment content found in other parts of the CR. The sediment is comprised of approximately 60 percent sand and 40 percent fine sediment.

Shoreline/Aquatic Vegetation: Minimal shoreline vegetation can be found at the Berths however, the shoreline between Berths 8 and 9 has an unarmored section. In this area, some herbaceous vegetation grows in a small alcove between the two berths. Aquatic vegetation is rare throughout this part of the action area due to its industrialized shoreline.

The shoreline at Willow Grove has a continuous band of riparian vegetation growing around the riprap, both native and non-native species. Currently the vegetation consists of grasses (*Poaceae sp.*), Nootka rose (*Rosa nutkana*), black elderberry (*Sambucus nigra*), snowberry (*Symphoricarpos albus*), willows (*Salix spp.*), dogwoods (*Cornus sp.*), black cottonwood (*Populus balsamifera ssp. trichocarpa*), Oregon ash (*Fraxinus latifolia*), Douglas hawthorn (*Crataegus douglasii*), Himalayan blackberry (*Rubus armeniacus*), reed canarygrass (*Phalaris arundinacea*), and indigobush (*Amorpha fruticose*). There's also aquatic vegetation is present at Willow Grove, specifically, the Eurasian milfoil and other pondweed species.

Hydrograph: The section of the CR that flows adjacent to the Berths and Willow Grove is typical of a high-energy river system. The CR moves large amounts of sediment from upstream in a series of sand waves until it reaches the ocean. The Port is located at RM 66, just downstream of the Cowlitz River. Water levels in the Cowlitz and Columbia rivers are regulated by multiple dams that manage river flows. Tidal influence at the sites result in daily water-level fluctuations between 2 and 4 feet, depending on the downstream flow severity. The CR system is dominated by upper river snowmelt, which contributes to lower flows during the summer and high freshets during the spring.

Water & Sediment Quality: Water quality in the Port and the Willow Grove is included on the ecology 303(d) List as a Category 5 for temperature and bacteria (Ecology, 2022). According to the most recent sediment evaluation framework guidance and the USACE's Portland Sediment Evaluation Team concluded that sediments found at the Port's Berths and at Willow Grove were free from harmful materials (USACE, 2017).

2.3.2 Species in the Action Area

All ESA-listed Columbia basin salmon and steelhead may rear and/or migrate through the action area, affecting the rearing and migration habitat PBFs for these species. Juvenile salmonids are likely to rear in shallow waters consisting primarily of sand/silt substrate near shorelines. Upstream and downstream migration of adult salmonids and smolts are likely to occur in the mainstem LCR. The survival of migrating fish has been reduced, due to the loss of multiple life-history stages as a result of habitat alteration. Similarly, eulachon migrate near the action area both as larval out-migrants and adults. Adult green sturgeon and sub-adults annually feed, and rest in the CR.

All the ESA-listed species considered in this opinion must migrate near the action area and thus, 100 percent could be exposed to the degraded baseline conditions as both juveniles and adults. Exposure to degraded habitat conditions may negatively affect the condition of individual fishes that will also be exposed to the effects of the proposed action. These effects can result in varying responses from these fishes. For this reason, we evaluate the effects of the environmental baseline on the listed species.

Salmonids in the action area would exhibit either a stream-maturing or ocean-maturing life history type. A stream-type life history is exemplified by juvenile salmon and steelhead that rear in upstream tributary habitats for over a year, such as the salmonids that migrate and spawn in the nearby Cowlitz River. Salmonids that exhibit this life history type include the LCR spring-run Chinook salmon, LCR steelhead, LCR coho salmon, MCR steelhead, UWR steelhead, UWR Chinook salmon, SR spring/summer-run Chinook salmon, UCR Chinook salmon, SR steelhead, SR sockeye salmon, and UCR steelhead. As juveniles, these fish would migrate through the action area as smolts (approximately 100 to 200 mm in size), move quickly downstream and pass by the action area within one to two days (Dawley et al., 1986).

Salmonids with an ocean-maturing life history type are exemplified by juveniles that move out of spawning streams and migrate to the LCR estuary as sub-yearlings and are actively rearing within the LCR estuary. Species that exhibit these life histories include the LCR fall-run Chinook salmon, CR chum salmon, and SR fall-run Chinook salmon. These fish are generally smaller in size (less than 100 mm) and more likely to spend days to weeks residing in tidal freshwater habitats characterized by the action area, with peak abundances occurring March through May (Hering et al., 2010; McNatt et al., 2016).

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

The consequence of systematic habitat loss is reduced habitat variety and a loss of species variety that relied on a complex of diverse conditions. According to Rich (1920), salmon present in the estuary during September–December 1916 consisted of a diversity of life history types, including recent upstream migrants and individuals that spent a significant period rearing in the estuary (Burke, 2004; Bottom et al., 2005). However, beach seining surveys since 2002 indicated that proportionally fewer juvenile salmon currently utilize the estuary throughout the late summer and fall (Bottom et al., 2011). The population curve is now skewed toward the period March–July and peaks between the spring and early summer. Analysis of historical data showed that there were at least six Chinook life history types in the CR, including five variants of sub-yearling life history, before extensive development in the CR basin (Rick, 1920). These strategies were distinguished by the length of time spent in each freshwater environment, time spent in the estuary, and time and size at the ocean entrance. Chinook salmon with estuarine rearing life histories are now substantially reduced in importance, leaving three principal life history types in the basin: fry migrants, sub-yearling migrants that rear in natal steams (including juveniles of hatchery origin), and/or main rivers and yearling migrants (Burke, 2004). LCR steelhead has lost four historical populations, and LCR Chinook diversity has declined by 8–10 historical populations. Further construction and habitat modification will result in the loss of more populations of ESA-listed fish, and these trends will continue.

2.4. Effects of the Action

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

Short-term effects of the proposed action are reasonably certain to include 1) short-term, localized increases of underwater sound pressure waves due to vibratory pile driving; 2) short-term, localized reductions in water quality due to pile removal and installation and possible construction debris entering the water; and 3) short-term and localized disturbance of benthic prey community due to pile driving.

Long-term effects of the proposed action are associated with the presence and operation of the Berths and Willow Grove: 1) shading caused by the presence of man-made structures within aquatic habitat;2) wake stranding from OGV traffic; 3) loss of cover and disruption of habitat forming processes caused by replacement of shoreline armoring; and 4) potential water quality impacts from ACZA-treated wood in the timber bulkhead and fender piles.

2.4.1 Effects on Critical Habitat

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

The action area includes the PBFs for freshwater juvenile habitat and migration corridors for all salmonids considered in this opinion. The essential elements of freshwater juvenile rearing habitat are 1) substrate; 2) optimum water quantity and floodplain connectivity (to form and maintain physical habitat conditions and support juvenile growth and mobility); 3) optimum water quality and forage (that support juvenile development); and 3) natural cover (such as shading, submerged and overhanging large wood, log jams and beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks).

The essential features of freshwater migration corridor PBFs include 1) freedom from obstruction and excessive predation; 2) optimum water quality and quantity conditions; and 3) natural cover (such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels, and undercut banks — which support foraging, mobility, and survival).

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

Underwater Sound Pressure Disturbance: The Port is expected to remove and replace damaged untreated fender piles at various locations along Berths 1–7. The piles are approximately between 12 and 16 inches in diameter. The Practical Spreading Loss model was used in the BA to determine the distance the sound pressure from vibratory pile driving diminishes to ambient sound levels. Based on WSDOT (2020), an ambient sound value of 120 dB_{RMS} is used as a reference sound level. Vibratory pile removal and replacement are expected to produce approximately 150 dB_{RMS} underwater based on project reports completed by Washington State Ferries at Port Townsend (WSDOT, 2011). However, underwater noise levels are not expected to exceed the fish disturbance threshold of 150 dB_{RMS}. Based on the Practical Spreading Loss model and attenuation distances, underwater sound generated from vibratory pile driving 16-inch wooden piles would require no more than 0.62 miles from the point of measurement to attenuate to 120 dB_{RMS} (Anchor QEA, 2022).

The type and intensity of the underwater sound waves produced by vibratory pile driving is dependent on a few factors. These include the type and size of the pile, the firmness of the substrate, the depth of water into which the pile is being driven, and the type and size of the pile driving hammer (Nedwell & Edwards, 2002). Driving steel piles with an impact hammer tends to generate pressure waves of greater amplitude that are more harmful than those generated by impact driving of concrete or wood piles. Sound pressure levels (SPLs) associated with wood pile installation are characterized by a longer rise time than steel piles. Vibratory installation of any pile type creates sound waves with a lower amplitude and higher frequency than what is created with impact driving.

Water Quality/Turbidity: The water quality for ESA-listed species present would be temporarily affected by increased turbidity during pile removal and installation at the Berths. Once in the water column, the CR would transport the suspended sediment downstream. In an evaluation of vibratory pile removal by Weston Solutions (2006) at Jimmycomelately Creek, suspended sediment concentrations from activating the vibratory hammer to loosen the pile ranged from 13–42 milligrams per liter with an average of 25 milligrams per liter of sediment. A 10–16 diameter plume extended approximately 1–20 feet from the removal site. We expect areas of turbidity associated with the proposed pile maintenance would be similar in scale for each removal and installation.

The sediment at the Berths are mainly composed of sand and are expected to settle out of the water column quickly (Newcombe & Jensen, 1996). We then assume that while pile removal and installation increases turbidity, any elevations because of the action would be localized, temporary and similar to water quality variations that occur normally in the riverine environment. The riverine environment is regularly subject to strong winds and currents that generate suspended sediments. Increased suspended sediments during the action would return to baseline levels as soon as pile maintenance activities are completed.

Water Quality/Contaminants: The water quality for ESA-listed species present would be adversely impacted by the use of ACZA-treated timbers in the replacement of the timber bulkhead or fender piles for the duration of time that those structures remain in the river. A pesticide-treated wood structure placed in or over flowing water will leach copper and a variety of other toxic compounds directly into the stream (Hingston et al. 2001; Kelty and Bliven 2003; Poston 2001; Weis and Weis 1996). Leaching rates of trace metals from ACZA-treated lumber are initially higher when compared to other treated wood such as chromated copper arsenate (CCA) and ammoniacal copper quat (ACQ) (Dickey 2003). However, these differences are minor and leaching rates drop precipitously within days to weeks of installation (Poston 2001). Preservatives leached into water are more likely to migrate downstream compared with preservatives leached into soil, with much of the mobility occurring in the form of suspended sediment. If shavings, sawdust, or smaller particles of pesticide-treated wood generated during construction, use, or maintenance of a structure are allowed to enter soil or water below, they make a disproportionally large contribution to environmental contamination because the rate of leaching from smaller particles is 30 to 100 times greater than from solid wood (FPL 2001; Lebow 2004; Lebow and Tippie 2001). Therefore, we anticipate that the water quality within the footprint will be most significantly impacted in the short-term, with continued leaching at much lower rates occurring for the duration of the structure within the water. NMFS expects that the BMPs intended to contain and remove sawdust during construction will significantly limit the large contribution of leached contaminants into the CR during construction.

Man-made Structures/Shade: Dock structures and moored vessels present at the Berths and Willow Grove may attract juvenile salmonid predators to shallow water areas due to shading they may produce. The proposed action extends the duration of possible shading impacts into the future (i.e., extending the lifespan of the existing structures). Although it is difficult to precisely pin-point the effects based on timeframes (temporary vs. long-term), it should be assumed that the effects described here do not include effects of the structures in the temporary sense. Juvenile salmonids are usually reluctant to enter shaded zones created by over-water structures, piles, and moored vessels. These areas create favorable ambush habitat for predators such as smallmouth bass, largemouth bass, and pike minnows. The overwater shade and the slower stream velocity caused by these structures can be easily exploited by these piscivores.

Martinelli & Shively (1997) found that pike minnows were present in all CR study locations with stream velocities of less than 1 meter per second. Faler et al. (1988) monitored the movements of 23 pike minnows below the McNary Dam and found they would utilize habitats with water velocities ranging from 0–0.70 meters per second. Smallmouth bass found in the McNary reservoir also preferred to use slow velocity habitats and individuals found in nearshore locations utilized floating structures and pilings (Pribyl et al., 2005; Tabor et al., 1993). Some other studies suggest pike minnows and smallmouth bass seek out low velocity habitats and utilize overwater structures for cover (Rondorf et al., 2010). We assume that the Berths, Willow Grove and the vessels that moor in these locations would be used by piscivores to ambush juvenile salmonids. Additionally, migrating smolts that swim near the Berths or Willow Grove would be more vulnerable to avian predators. These birds may perch on dock structures or moored vessels.

Piscivorous birds present in the CR that feed on juvenile salmonids include Double-crested cormorants, California and Ring-billed gulls, and Caspian terns. The extended lifespan of these structures and the presence of moored vessels extends the conditions that encourage the presence of piscivorous birds that negatively affect safe passage of juvenile salmonids.

Shading from the dock structures and moored vessels also has the potential to impact forage opportunities by perpetuating disturbances to benthic communities. Overwater shade can disrupt the growth of aquatic vegetation, reducing forage availability for juvenile salmonids and other small fish that comprise the adult salmonid prey base (Sagerman et al. 2009). The Port's berths do not support aquatic vegetation due to the CR's high velocity flow, sediment transfer, and the low light penetration in the depths being discussed. Furthermore, the Columbia River Estuary exhibits a very low level of organic content and fine sediment habitat supporting benthic communities within the Freshwater Zone's Main Channel Center and Main Channel Sides, where the Berths and Willow Grove Park are located (Holton 1984). The proposed action extends the duration of possible shading impacts on benthic communities, though given the natural conditions of the Lower Columbia River, this impact is expected to be relatively minor.

Forage: Fender pile maintenance at the Berths is likely to result in sediment disturbance that would temporarily reduce benthic prey. The sediment is mostly composed of sand which would quickly settle out of the water column. This would allow benthic species to recolonize the sediment soon after the action is completed and are expected to return to baseline levels within a few weeks.

Natural Cover: The proposed action would have no effect on existing natural cover. As mentioned in Section 2.3.1, the Berths have little shoreline vegetation between Berths 8 and 9, and contains little to no aquatic vegetation. However, the replacement of up to 4,000 linear feet of the timber bulkhead would extend the duration of the degraded condition of this habitat and prevent the formation of natural cover from undercut banks, side channels, or aquatic vegetation. Flood-control levee systems have isolated the CR within the project footprint, altering sediment transport regimes and severely degrading the quality of this PBF for ESA-listed species (Cannon 2015). While the shoreline armoring replacement would not extend these impacts to new areas, the proposed action would perpetuate the degraded condition and function of this habitat within the project footprint. Willow Grove Park exhibits more natural habitat features, including plentiful riparian and aquatic vegetation. The maintenance of breakwater structures at the park could likewise prevent natural cover from establishing, though in a very small footprint.

Noise Disturbance from boat/vessel traffic: Noise and disturbance from the interrelated boat/vessel use are also temporary but would occur periodically. This would occur whenever boats/vessels moor or travel from the Berths or Willow Grove over the life of the structures. A study found that boat noise can induce stress responses via increased cortisol concentration in fishes (Nicholes et al., 2015). We cannot predict the frequency of recreational boat/commercial vessel use, but if such use coincides with juvenile salmonid presence, it is likely to temporarily disrupt normal fish behavior. These behaviors include rearing, feeding, sheltering, and migration.

2.4.2 Effects on Listed Species

Effects of the action on species is based on the exposure of individual fish to the habitat changes described above, or effects on the fish themselves. In this case, 14 ESA-listed species migrate through the action area. All species would be exposed to permanent habitat effects described above, whereas some may experience varying, temporary effects of the proposed action depending on their migration timing and duration in the LCR. The length of time each fish spends in the action area is dependent on their life stage. Adult salmonids are likely to travel upstream and through the action area within a short timeframe. Juvenile salmonids may spend hours to months within the action area depending on the species. Foraging by juvenile salmonids usually occurs at depths less than -20 feet. The deeper water and faster river flows found in the CR flow lane would provide a migration corridor for adults and larger juveniles.

The exposure of ESA-listed fish species to short-term habitat changes in the action area are dependent on the timing and location of the action and the density and life history stage of the ESA-listed fish present (Table A1). The level of exposure experienced by each fish is directly related to the time and frequency of the maintenance actions. Fender pile maintenance would occur for a maximum of two 20-day work periods (3 weeks each). One work period would occur in the spring/summer and the other would occur during the agency approved IWWW of October 1–December 31. Dock structure maintenance and bank stabilization actions at the Berths would occur on an ongoing basis during favorable environmental conditions. Other maintenance and repair actions above the OHWM and woody debris removal would occur year-round as needed.

Salmonid Exposure and Effects

Adult salmonids. Though peak migration periods vary by species, some adult CR salmonids are reasonably certain to be present in the action area during fender pile maintenance, and would be exposed to the effects of the action. Adult Chinook salmon presence in the action area is most likely from late spring through the fall. Adult coho salmon are likely to be present from late summer through early winter. Adult chum salmon primarily occur during the fall. Adult sockeye salmon presence most likely ranges from late spring to late summer. Adult steelhead presence ranges from February to December, although majority of upstream passage through the LCR occurs during the spring and summer (Columbia Basin Research, n.d.). Based on the broad timing of these species, and the proposed work periods of spring/summer and October 1 to December 31 for pile removal and installation, exposure for all adult salmonid ESUs is highly likely. All ESUs would encounter permanent habitat affects due to the maintenance actions.

Adult salmonid migration speeds range between 1.0–2.6 kilometers per hour (Quinn, 1988). Therefore, we expect adult ESA-listed salmonids that do encounter underwater noise and turbidity plumes created during pile maintenance to move upstream at a rate that would limit their exposure to a few minutes. Adult salmonids typically migrate within the mainstem CR channel at depths of 10–20 feet below the water’s surface and off the bottom (Johnson et al., 2005).

<u>Exposure to underwater noise</u>: The timing of the proposed vibratory pile driving is set to occur once during the spring/summer and during the agency-approved IWWW of October 1–December 31 when adults would be present in the CR. Sound waves transmitted through the water column

have the potential to result in behavioral responses from individual adults; however, as underwater noise levels from vibratory driving are not expected to exceed the fish disturbance threshold of 150 dB_{RMS}, this proposed activity would not reach the threshold known to harm them or disrupt normal behavioral patterns. SPLs associated with the installation of wood piles are characterized by a longer rise time compared to steel pile installation (as mentioned in Section 2.4.1). Rise time seems to be an important factor to consider in determining whether a sound pressure wave is likely to cause physical damage (Carlson et al., 2001; Nedwell & Edwards, 2002). Additionally, sound pressure waves from vibratory pile driving are much shallower than waves produced from impact driving and do not result in physical injury to fishes. When activated, vibratory hammers produce sound pressure levels approximately 17 dB lower than those produced by an impact hammer (Nedwell & Edwards, 2002). No empirical studies have reported any injurious effects from vibratory driving as far as NMFS is aware. Based on the type of pile (wood) and the installation method (vibratory driving) we do not expect sound pressure waves to result in behavioral changes or injury to fish present.

Behavioral response studies have been done on salmonids and their responses under pile driving conditions. A study conducted by Grette (1985) investigated the impacts of steel sheet pile installation on adult Chinook, coho, and sockeye runs through the Hiram H. Chittenden Locks in Seattle Washington. This study found that the daily migration patterns through the locks were similar during periods of pile driving, and during periods of no pile driving. The study concluded that pile driving did not have an impact on the number of salmon entering the fish ladder at the locks.

Feist et al. (1996) observed the behavior of juvenile pink and coho salmon during a wharf construction at Everett Homeport in the Snohomish estuary. Concrete piles were driven with impact hammers using two pile driving rigs that operated for periods of 8–10 hours per day for 3 days (i.e. Monday, Wednesday, & Friday). The study found little to no changes in fish behavior. On days of no pile driving, the fish exhibited a definitive schooling pattern. On days of pile driving, the fish distributions appeared to change around the site. Specifically, schooling patterns appeared to move towards a sound isolated area of the site on pile driving days more than on non-pile driving days. The prevalence of fish schools also did not change significantly in the presence or absence of pile driving. Feist et al. (1996) concluded that the study was unable to demonstrate whether pile driving had a detrimental effect on the juvenile salmonids observed.

Another study placed juvenile coho salmon in cages between 6 and 45 feet from 14 steel piles while exposing them to 1,627 strikes during a 4.3-hour period (Ruggerone et al., 2008). Startle responses were observed for a small portion of fish and only 4 out of the 14 first strikes, behavioral responses by salmon tended to be very subtle. These responses also tended to occur when the cages were close to the piles and sound pressure levels were high. Instances of a contractor walking past a cage caused a greater startle response. No internal or external injuries associated with pile driving were observed. The report concluded that coho salmon were not significantly affected by cumulative exposure to pile driving sounds produced in the study (Ruggerone et al., 2008).

Although numerous studies have attempted to discern how different fish species respond to elevated sound levels, relatively few papers have linked this exposure to effects on fish (Hawkins et al., 2014). Under some conditions, with some fish species, elevated sound may cause some behavioral responses but it is not possible to equate those responses to other conditions and other species (Popper & Hastings, 2009). Davidson et al. (2009) indicated that studies have shown that salmonids do not have a wide hearing bandwidth or hearing sensitivity to sound pressure levels and are not as likely to be impacted by increased ambient sound.

The vibratory hammer would be operated for a relatively short duration of 0.5–2 hours per day over the course of two 3-week work periods and is expected to affect a few adult salmonids. If exposed, the response would not significantly hinder essential behavior and would be insufficient to cause injury to fish.

<u>Exposure to Increased Turbidity</u>: According to Newcombe and Jensen (1996), the effects of increased total suspended solids (TSS) can range from beneficial (improved survival by reduced predation) to detrimental (physiological stress and reduced growth). During vibratory pile removal and installation, there is usually a small increase in turbidity in the area where driving occurs. Fish in vicinity of the action are likely to experience temporary increases in TSS and exhibit sublethal responses (Newcombe & Jensen, 1996). These responses may include gill flaring, coughing, and a temporary reduced feeding rate. The river flow environment in the action area is typical for a high-energy system. Consequently, suspended sediment in this area would be quickly mixed and diluted by the river currents over the course of approximately half an hour during the proposed fender pile maintenance.

Constant exposure to turbid conditions by fish may cause physiological stress responses that increase an individual's maintenance energy needs, and reduce feeding and growth (Lloyd et al., 1987; Redding et al., 1987; Servizi & Martens, 1991). However, the temporary duration and low intensity nature of the proposed action make the possibility of constant exposure to turbid conditions very unlikely. The expected temporary duration of turbid conditions along with the low increase in TSS expected by the proposed action may result in the exposure of a few ESA-listed species. These fish are not likely to be present in the action area long enough to experience any beneficial or adverse effects caused by turbid conditions.

Larger adult salmon quickly respond by avoiding turbid areas to find refuge and/or passage conditions within unaffected locations nearby. A study by Bisson and Bilby (1982) found that salmonids are able to detect and distinguish turbidity and other water quality gradients. Other studies show that larger salmonids are more able to tolerate elevated TSS than smaller juveniles (Servizi & Martens, 1991, 1992). As salmonids grow and their swimming ability improves, they would depend less on shallow, nearshore habitats (Groot & Margolis, 1991). Consequently, we expect any adults exposed to a turbidity plume created during pile maintenance to traverse the action area without experiencing adverse effects.

<u>Exposure to Decreased Benthic Prey</u>: Adult salmon and steelhead do not have benthic invertebrates as a prey base. Adult salmon also usually cease prey consumption during their upstream migration (Quinn, 2018). Consequently, the reduction in invertebrate forage related to shade would not have any significant effect on ESA-listed species considered in this opinion.

Exposure to Man-made Structures/Shading: Adult salmonids are too large to be consumed by piscivorous fish that may use in-water and over-water structures as ambush habitat. Consequently, we do not expect the injury or death of adult salmonids due to the extended life of these structures as a result of the proposed action. Adult salmonids tend to travel through the middle of the river channel and in deeper water, unlike out-migrating juveniles that travel along the shoreline and in shallow water. Therefore, the adults traversing the LCR are least likely to encounter structures at the Berths and Willow Grove, and are least likely to experience adverse effects due to the presence of these structures. We expect that the few adults that may encounter structures at Willow Grove or the Berths would swim around and/or underneath the structures with little to no variation in their migration trajectory. To the extent that the in-water and overwater structures would modify critical habitat for an extended period, the presence of these structures would only slightly reduce the quality of the migratory corridor for adult salmonids.

Exposure to noise from boat/vessel traffic: Underwater noise associated with vessel traffic along major shipping routes creates a major disruption in aquatic animal behavior globally. While a majority of this research has focused on marine mammal behavior in response to anthropogenic noise, there is a growing body of literature detailing the numerous ways in which underwater noise from vessels alters the behavior of fish. These behavioral responses include moving away from the vessel noise (Vabo et al. 2002; Handegard et al. 2003), decreasing exploratory activity and reducing home range (Ivanova et al. 2020), increasing predation risk (Simpson et al. 2016), altering day-night migration patterns (van der Knapp 2021), and physiological changes resulting in interrupted courtship (Wysocki et al. 2016). We would expect adult salmon and steelhead to remain less affected by predation or altered forage behavior than their juvenile counterparts due to their size and life history at the time of exposure (adults will typically cease prey consumption during upstream migration). Therefore, we expect that underwater noise from vessels is most likely to affect adult salmon and steelhead by altering their migration patterns. This delayed migration will depend on the frequency of vessel traffic, as well as the size of the ship and the amount of underwater noise that it is generating. While it is difficult to quantify this effect on a population level, the intermittent nature of vessel traffic will likely not result in a significant reduction in salmon or steelhead use of the action area for migration.

Juvenile salmonids. The level of exposure of juvenile salmonids would vary depending on the species present, life history, location, migration timing, and water depth occupied. Juvenile salmonids migrate in the vicinity of and may rear in the action area during different times of the year. In general, juvenile salmonids are present in the action area year-round, being most abundant from late winter through summer, becoming less abundant in the fall (NMFS, 2017b). Juvenile Chinook salmon are present year-round with timing ranging from spring to early fall, although sub-yearlings are present later into the fall (Dawley et al., 1986; NMFS, 2017b). Juvenile chum salmon are present from winter to spring. Juvenile coho salmon and steelhead are present year-round with their primary timing ranging from spring to mid-summer. Juvenile sockeye are present during mid-spring to late summer.

While we expect all juvenile salmonid ESUs would experience permanent habitat effects of the action during some point of their downstream migration, depending on their timing, some salmonid ESUs may experience temporary effects as a result of the pile driving work window. Juvenile salmonids migrate through the action area at different rates that vary among species and

life history. Many early life history strategies of CR salmonids have been lost due to past management actions discussed under the environmental baseline (Bottom et al., 2005).
In this context, sub-yearling migrants are more likely to be subjected to both the proposed action and permanent habitat effects, due to their tendency to migrate and/or rear in the action area during the proposed work window. The agency approved IWWW for the proposed action would occur during time periods where the density of sub-yearlings would be low, and limits the number of species exposed. Most fish will travel past the action area before/after the IWWW. We assume a small number of juvenile salmonids would be exposed and present our effects analysis below.

<u>Exposure to underwater noise</u>: Juvenile salmonids would most likely respond to underwater noise caused by vibratory pile driving similarly to the adult salmonids (mentioned above). The explanation above also includes studies by Feist et al. (1996) and Ruggerone et al., (2008) that observed juveniles during periods of pile driving. SPLs produced by vibratory pile driving are not known and are not expected to exceed the threshold that may physically injure fishes. Some sub-yearling migrants within the action area may be affected by pile maintenance and temporarily leave the rearing habitat. Due to the limited time required for pile removal and installation, and the method used, a small amount of fish are likely to be exposed to underwater noise. The behavioral responses of juveniles may increase their risk of injury and/or being preyed upon.

<u>Exposure to increased turbidity</u>: Juvenile salmonids exposed to elevated TSS and turbidity would react similarly to adult salmonids (mentioned above). Due to juveniles mainly occupying shallow water habitat, the risk of exposure to turbidity is greater for sub-yearling salmonids than yearling salmonids and adults. The proposed IWWWs that may include spring/summer months along with the agency-approved window of October 1–December 31, there is a possibility for more than a few species to be present in the action area during the proposed fender pile maintenance. Given the small area of the river affected, the temporary duration of the action (approximately six weeks each year of pile maintenance), and the short duration of elevated TSS (due to pile driving method and sediment composition), and the capacity of fish to avoid turbid areas, we expect effects among the juveniles exposed to be minor.

<u>Exposure to decreased benthic prey</u>: The benthic prey if juvenile salmonids are likely to be diminished due to the elevated TSS caused by the proposed fender pile maintenance. Effects on the prey are likely to be minor among juveniles, affecting those rearing in the action area more than those migrating through the action area. Rearing juveniles with less available prey in the action area are expected to find suitable areas in nearby unaffected areas, but may experience increased competition for those prey resources. Additionally, in-water structures in the action area may provide foraging habitat and may compensate for the loss of benthic prey. According to Carrasquero (2001), juvenile salmonids may prey on periphyton, insects, and macroinvertebrates adhered to in-water structures in the CR.

<u>Exposure to man-made structures/shade</u>: We expect most juvenile salmonids to encounter the in-water and over-water structures at the Berths and Willow Grove due to the permanence of these structures. Juveniles would respond to these structures by swimming around them, which would slightly lengthen their migratory pathway. Such adjustments to their migration route can

potentially be an adverse effect. These route alterations may increase individual energy expenditure, increase opportunities for predators to prey on juveniles, and has been shown to be correlated with mortality (Anderson et al., 2005). Rearing juveniles may also experience degraded habitat conditions due to the structures and the shade they produce. Shade reduces forage opportunities for juveniles and displaces smaller juveniles from shallow water rearing habitat. Consequently, to the extent in-water and overwater structures would modify critical habitat over an extended period, these structures would reduce the quality of the migratory corridor and rearing habitat to some extent.

The in-water and overwater structures (i.e., floating docks and concrete breakwater at Willow Grove and the metal, asphalt, and concrete dock structures, and fender piles at the Berths) would create areas of cover that slow the water velocity and/or create shade. As mentioned in Section 2.4.1, the Dock structures at Willow Grove have grated decking and there is minimal overwater coverage at the Berths. These conditions may create favorable habitat for predators such as northern pikeminnow, smallmouth bass, and largemouth bass (Faler et al., 1988; Isaak & Bjornn, 1996). Northern pikeminnow and smallmouth bass have consistently been shown to use low-velocity habitats (Faler et al., 1988; Isaak & Bjornn, 1996; Martinelli & Shively, 1997). In CR reservoirs, their preference for low-velocity habitats associated with overwater structures places them in the paths of out-migrating juveniles (Carrasquero, 2001). In the McNary reservoir, smallmouth bass have also been found to prefer low-velocity habitats (Tabor et al., 1993). Additional studies cited by Rondorf et al. (2010) found similar findings on these juvenile salmonid predators. These studies found that pikeminnow and smallmouth bass actively search for low-velocity habitats, prefer shaded areas, and utilize overwater structures such as docks.

Many of the structures present in the action area may create some shade and reduce water velocity that could likely make existing habitat conditions more attractive to predators. From the findings of the studies previously presented, we can suppose that the continued maintenance of the structures at the Berths and Willow Grove would extend the use of shaded and low-velocity areas by piscivorous fish. We can also expect these structures to reduce the quality of juvenile salmonid critical habitat for rearing and migration in the action area for the extended lifespan of the structures.

<u>Exposure to ship wake stranding</u>: A consequence of the proposed action is the continuation of ocean-going vessel (OGV) traffic on the CR to and from the Berths into the future. OGVs (specifically deep draft vessels) produce long period wake waves that can erode shoreline habitats and strand juvenile fishes. The fishes can be carried onto beaches by these waves above the point where waves can return them the river. Ship wake stranding is a primary contributor to a low-priority limiting factor of CR salmonids (NMFS, 2011). A few studies have indicated that under certain conditions, these vessels can produce wakes that strand juvenile salmon in the CR. In 1975, it was estimated that 14,500 juvenile Chinook, 1,359 juvenile coho, and 4,771 juvenile chum salmon were stranded due to ship wakes from 180 OGVs (Bauersfeld, 1977).

Pearson et al. (2006) examined fish wake stranding at three beaches in the LCR in the summer of 2004, winter of 2005, and spring of 2005. In this study, 126 deep-draft vessels were monitored and juvenile stranding occurred at all three sites during the three seasons observed. The percentage of vessels that caused stranding varied among the three sample sites. The authors found that multiple factors were involved in the probability of wake stranding. The factors observed in this study include proximity to the shipping lane, tidal stage, tidal height, river flow, flow velocity, vessel type, vessel transit route, vessel load (i.e., loaded/unloaded), vessel speed, vessel size, fish abundance, beach characteristics (e.g., slope, shielding factors), and total wave excursion. In this study, a proxy for ship kinetic energy (accounting for ship size and speed), and fish abundance were found to have the greatest association with stranding occurrences, but the authors noted expressly that no single factor could be constructed to govern the likelihood of stranding.

Considering these findings, the authors conducted a subsequent spatial analysis to characterize other beaches that might be susceptible to juvenile stranding (Pearson et al., 2011). This was done using the confinement of the channel, distance of the beach from the navigation channel, beach shielding features, beach slope, submerged berms in the navigational channel, and fine scale beach features. Data from the LCR Estuary Partnership for fine scale features, NOAA and USACE data on bathymetry, and aerial photography from the U.S. Department of Agriculture were also used in the spatial analysis. Pearson et al. (2011) determined that a beach's juvenile standing susceptibility based on physical features alone is likely limited to approximately 16 percent of the LCR (about 33 miles) mostly upstream of RM 63. These areas along the CR are characterized by shorelines closer to the navigational channel, lack of shielding from wave action, and beach slopes less than 10 percent. Applying these parameters, the authors concluded that the highest susceptibility of stranding occurs on about 8 miles of shoreline in the LCR recovery domain, upstream of RM 25.

Additional wake stranding data has been collected for almost 2 years consistently (2–10 surveys a week) along the CR shoreline (approximately RM 87) at the mouth of the Lewis River. This data was collected by Plas Newydd LLC (sponsors of the Wapato Valley Mitigation and Conservation Bank) located upstream of Willow Grove and the Berths. The data collected indicates a pattern of stranding events during lower water surface elevations in the CR starting in early January through early April coinciding with juvenile fish presence, and OGVs traveling to upstream ports or down the CR. The findings of the monitoring and data collection indicate that an average 27.3 percent of OGVs resulted in stranded juvenile salmonids and 37.8 percent stranded fish of any species. Of those OGVs that stranded salmonids, salmonids were stranded at an average rate of just over 10 fish per vessel survey, ranging from as low as two fish stranded to a high of 300 fish stranded per OGV passage at this location (K. Jorgensen, personal communication, 2020).

Pearson et al. (2006) concluded that fish stranding occurred with bulk carriers, container ships, oil tankers, and car carriers but was not observed with tug boats or smaller vessels transiting the navigation channel. Smaller recreational boats also have been observed by other NMFS personnel to cause stranding in other river systems when operating at fast speeds closer to the shore (D. Bambrick, personal communication, 2017). Different vessels, depending on their size and bow configuration, can produce different patterns of wave draw-down and surge. From modeling different variables, ship speed was estimated to have the greatest effect on wave generation. According to Pearson et al. (2006), if a ship with a 16-meter beam's speed is reduced from 14 knots to 12 knots, there may be a 63 percent decrease in wake height.

The Columbia River Estuary ESA Recovery Plan Module states that there are limited options in terms of reducing the incidence of juvenile wake stranding (NMFS, 2011). This is mainly due to the loss of revenue that would result from slower ship travel. Ship traffic through the estuary would continue, and the speed of the ships traversing the CR may be difficult to alter because of safety concerns. While it is difficult to accurately project how many OGV calls the Port will receive annually, NMFS has determined in consultation with the Port that this number is not likely to exceed 400 OGV calls each year within the next 40 years. The U.S. Coast Guard regulates traffic and speed within the LCR navigation channel. The modification of some habitats may be necessary to reduce wake stranding effects.

Exposure to noise from boat/vessel traffic: As discussed above, recreational boat/commercial vessel activity is known to cause physiological stress to fish (Nicholes et al., 2015). However, the effect is only expected intermittently for a few minutes at a time. The fishes that encounter noise would likely move away from the area. Due to the intermittent nature of the disturbance and the ability for fish to move away, we do not expect this effect to be meaningful to the survival of adult or juvenile fish that encounter noise disturbance from boats/vessels.

Eulachon. Adult eulachon traverse large tributaries of the CR during the late winter and spring. They produce 7,000–60,000 eggs with an adhesive exterior that sticks to the substrate (gravel or sand) until larvae hatch and are transported downstream via river flow (Parente & Snyder, 1970; Smith & Saalfeld, 1955; Wilson et al., 2006). Eulachon larvae rapidly disperse throughout the water column and are widely distributed as they passively drift downstream (Howell & Uusitalo, 2000). Adult eulachon may return as early as late November; however, migration usually occurs during March and April (NMFS, 2016). We expect that any adult eulachon present in the action area would have a similar response to the effects caused by the proposed action (i.e., temporary increase in turbidity, temporary decrease in benthic prey, and temporary increase in underwater noise) as the salmonids would. Eulachon exposure to underwater noise and resulting effects would be similar to those of salmonids, although eulachon do not have swim bladders and are not as susceptible to barotrauma (Caltrans, 2015). The effects of underwater noise exposure to eggs and larvae are not well documented. We do not anticipate eulachon would be present during the IWWW of October 1–December 31, however, they are likely to be present during the other work window in the spring/summer. If/when they are present in the action area, the short duration of the vibratory hammer during fender pile maintenance and the relatively sub-injurious effects of this equipment are such that we expect effects on eulachon would be similar to those of salmonids.

In years of great abundance, large numbers eulachon may return to the CR. Some of these individuals would migrate through the action area to access spawning sites in nearby watersheds including the Cowlitz, Elochoman, Kalama and other watersheds. Some adult eulachon, including their eggs and larvae would be exposed to permanent habitat effects of the proposed action. The action area is not identified as a spawning area, and if spawning did occur the presence of the Berths and Willow Grove would not restrict access to this area for either spawning or migration. Larval eulachon traverse the action area via drifting downstream and may not be affected in their downstream migration. Adult eulachon are likely to respond to permanent habitat effects similarly to adult salmonids, by a slight adjustment in their migration pathway. Adult eulachon are typically 6–8 inches in length, and is usually beyond the gape limit of all piscivorous fish except for the largest fish found in the LCR. Thus, we do not anticipate this species to be subjected to increased predation risk because of the proposed action.

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 versus cumulative effects. Therefore, all relevant future climate-related environmental conditions in the action area are described earlier in the discussion of environmental baseline (Section 2.3).

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

Development trends indicate that upland private and public actions that affect the action area will continue. NMFS looked for but did not find any proposals for specific, local project proposals within or adjacent to the action area that would not require a Federal permit consultation. However, as the population in and around Longview grows, demand for residential development and infrastructure in the upland and riparian zones is likely to grow. We believe most environmental effects related to future growth will be linked to land-use changes and increased impervious surfaces that can affect shallow water habitat quality and deliver contaminants to substrates near the action area. State, county and city regulations should minimize and mitigate for the adverse effects of this development so that the overall environmental quality of the action area remains constant, albeit degraded relative to its restored condition.

Similar activities outside the action area would also influence conditions within the action area. Approximately 6 million people live along the LCR, concentrated largely in urbanized areas. The legacy of resource-based industries (e.g., agriculture, hydropower facilities, timber harvest, fishing, and metal and gravel mining) caused long-lasting environmental changes that harmed ESA-listed species and their critical habitats. Stream channel morphology, roughness, and cover, estuarine rearing habitats, wetlands, floodplains, riparian areas, water quality, fish passage, and habitat refugia has been degraded throughout the LCR basin. Those changes reduce the ability of populations of ESA-listed species to sustain themselves in the natural environment by altering or interfering with their behavior in ways that reduce their survival throughout their life cycle.

While widespread degradation of aquatic habitat associated with intense natural resource extraction is no longer common. Ongoing land management actions are likely to continue to adversely affect the estuary and delay natural recovery of aquatic habitat in the CR basin including the action area. This trend is somewhat countered by non-federal aquatic habitat restoration occurring in the LCR. The Lower Columbia River Partnership has over 100 regional partners in the LCR and has completed 253 projects with a total of 33,113 acres of habitat restored (LCREP, 2023). Projects include land acquisitions and conservation easements, adding large logs to streams to create fish habitat, planting trees to shade and cool streams, and removing barriers to fish passage. Still, when considered together, the net cumulative effects are likely to have an adverse effect on salmon and steelhead.

2.6. Integration and Synthesis

The Integration and Synthesis section is the final step in assessing the risk that the proposed action poses to species and critical habitat. In this section, we add the effects of the action (Section 2.4) 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) reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing its numbers, reproduction, or distribution; or (2) appreciably diminish the value of designated or proposed critical habitat as a whole for the conservation of the species.

2.6.1 ESA Listed Species

Considering the status of the ESA-listed species, all but two of the species considered in this opinion are threatened with extinction. Those two species are the UCR spring-run Chinook salmon, and SR sockeye salmon which are endangered. Most of the component populations of LCR Chinook salmon, UCR spring-run Chinook salmon, SR spring/summer-run Chinook salmon, UWR spring-run Chinook salmon, SR fall-run Chinook salmon, CR chum salmon, LCR coho salmon, SR sockeye salmon, LCR steelhead, MCR steelhead, UCR steelhead, SRB steelhead, UWR steelhead, and the Southern DPS of Pacific eulachon are at a low level of persistence. All individuals from populations of these listed species are likely to move through the action area at some point during their life history.

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

Within this context, the proposed action would create a brief physical disturbance in the water column (via noise and turbidity), along with extending the life of in-water and overwater structures that may modify fish migration and provide ambush habitat for piscivorous fish, and reduce the abundance of benthic prey for juveniles. The maintained in-water and overwater structures would disrupt the rearing and migration of ESA-listed species and augmented predator habitat that would exist for a longer period. These habitat alterations would displace a small number of adult and juvenile fish as they migrate around the structures at the Berths and/or Willow Grove. A small number of juvenile fishes migrating near the structures may be consumed by piscine predators using these structures as refugia and foraging habitat. Due to the lack of shoreline vegetation and industrial nature of the Berths, it does not provide a suitable habitat for juveniles. Rearing conditions are slightly impaired at the Willow Grove due to shoreline armoring however, the presence of shoreline vegetation may provide off-channel refugia for juvenile salmonids.

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

However, even when we consider the status of the threatened and endangered fish populations and degraded environmental baseline within the action area, the proposed action itself is not expected to affect the distribution, diversity, or productivity of any of the populations of ESA-listed species at a measurable level. The effects of the action would be too minor to have a measurable impact on the affected populations since no population is expected to experience a greater proportion of the negative effects on abundance. Because the proposed action would not reduce the productivity, spatial structure, or diversity of the affected populations, when combined with a degraded environmental baseline and additional pressure from cumulative effects, the action would not appreciably affect the listed species considered in this opinion.

2.6.2 Critical Habitat

Critical habitat throughout the range of these species is ranked at the watershed scale. Most watersheds (or hydraulic units) have had degradation to some or all PBFs in varying degrees, but many watersheds are still ranked as having medium to high conservation value due to the importance of the role those watersheds serve for the species' life cycle.

In the context of the status of critical habitat and the specific baseline conditions of PBFs in the action area, the proposed action may create a slight obstruction to the passage of juvenile fishes, but would not reduce the existing natural cover at the Port's facilities, alter water temperature, or substantially reduce available forage. The replacement of the timber bulkhead will perpetuate the existing heavily degraded conditions of the natural cover PBF, however, and will prevent the establishment of undercut banks, side channels, or other essential habitat features for juvenile salmonids. When considering the cumulative effects of non-federal actions, recovery of aquatic habitat is likely to be slow in most of the action area and cumulative effects from basin-wide activities are likely to have a neutral to negative impact on the quality of critical habitat PBFs.

The critical habitat for migration and rearing is functioning moderately under the current environmental baseline in the action area. Given that the proposed action would have a short, highly-localized, low-level effect on the PBFs for migration, rearing, and spawning, even when considered as an addition to the baseline conditions, the proposed action is not likely to reduce the quality or conservation value of critical habitat for any species considered in the consultation.

2.7. Conclusion

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

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 kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including breeding, spawning, rearing, migrating, feeding, or sheltering (50 CFR 222.102). "Harass" is further defined by interim guidance as to "create the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding, or sheltering." "Incidental take" is defined by regulation as takings that result from, but are not the purpose of, carrying out an otherwise lawful activity conducted by the Federal agency or applicant (50 CFR 402.02). Section 7(b)(4) and section 7(o)(2) provide that taking that is incidental to an otherwise lawful agency action is not considered to be prohibited taking under the ESA if that action is performed in compliance with the terms and conditions of this ITS.

2.8.1 Amount or Extent of Take

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

- Injury or death to juvenile salmonids caused by wake stranding from OGVs.
- Harm from exposure to increased turbidity and reduction in prey availability.
- Death of juvenile salmonids from predacious fish utilizing shade cast by the overwater structures and vessels utilizing the Port Berths.

A definitive number of ESA-listed species that may be killed, injured, or harmed cannot be estimated or measured. This is mainly due to the highly variable presence of ESA-listed species over time, and the inability to observe all the individuals who may be injured or killed. Instead, NMFS will use habitat-based surrogates to account for incidental take called an "extent" of take.

These surrogates are quantifiable, can be monitored in real time so that it serves its role as a meaningful re-initiation trigger and is causally related to the harm.

Harm from increased turbidity and decreased prey availability: Juvenile salmonids and Pacific eulachon present in the at the Berths may be harmed, injured or die during fender pile maintenance activities. Specifically, the additional turbidity produced during the action is likely to diminish benthic prey resources during and following the completion of construction activities. Benthic prey community abundance may be affected by the action, reducing the available prey to fishes in the area affected. In this case, the surrogate is the total number of piles replaced for the project. The number of piles replaced corelates to the area of turbidity and benthic disturbance. If the number of piles replaced exceeds 160, the take limit is exceeded and the opinion must be re-initiated. This surrogate serves as an effective re-initiation trigger because, the number of piles can be tracked on a continuous basis.

Injury or death from OGV traffic: OGVs traveling to and from the Berths over the next 40 years would produce long period waves that may cause injury and death to juvenile salmonids from ship wake stranding. At this time, the limited data associated with wake stranding is considered insufficient to provide an exact take estimate, as the conditions that cause wake stranding depend on multiple variables. The number of OGVs travelling to and from the Berths are just a fraction of the total OGV traffic in the LCR. Therefore, NMFS is using 400 OGV calls per year to the Port over the course of 40 years as a surrogate for quantifying take consistent with 50 CFR § 402.14(i)(2). Using 400 OGV calls to the Port as a surrogate establishes a clear standard for determining when the level of anticipated take has been exceeded. For example, if the number of OGV calls to the Port exceeds 400 OGVs in less than a year, we expect that the anticipated effects and resulting take would also be exceeded. Even though the surrogate mirrors the number of assumed vessel traffic, it functions as an effective check on the ongoing validity of the analysis because it is an annual measurement that can be monitored by the applicant. That means, each year there is an opportunity to check whether the assumption of a total of 400 OGV calls to the Port over 40 years has been exceeded. As a result, we believe that OGV calls are an easily assessed, effective and reliable take surrogate that meets the legal standards as they relate to a re-initiation trigger.

Harm from overwater structures and vessels casting shade: The overwater structures at the Port Berths and the mooring vessels cast shade and reduce water velocity within the CR, exposing juvenile salmonids to a greater risk of predation. The continued maintenance of the dock structures at the Berths would extend the use of shaded and low-velocity areas by piscivorous fish, resulting in injury and death to juvenile salmonids. The surrogate for incidental take is the number of treated timbers located under the berth deck that will be replaced as part of the project. If the number of timbers replaced exceeds 200 annually or 800 in total, the take limit is exceeded and the opinion must be re-initiated. The surrogate serves as an effective re-initiation trigger because the number of timbers being replaced can be tracked on a continuous basis.

2.8.2 Effect of the Take

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

2.8.3 Reasonable and Prudent Measures

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

1) Minimize incidental take caused by turbidity; and
2) Implement a monitoring plan to confirm that incidental take from the proposed action is not exceeded.

2.8.4 Terms and Conditions

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

1. The following terms and conditions implement RPM 1:
    a) Make visual observations for turbid conditions at a point 300 feet downstream during construction.
    b) If turbidity creates a visible plume beyond the edge of the 300-foot mixing zone, stop work and install a floating silt curtain around the in-water construction area before resuming work, to minimize the dispersion of suspended sediment and reduce turbidity.
    c) Ensure that in-water work occurs in accordance with timing restrictions, limited to October 1 to December 31, and the month of August only if necessary.

2. The following terms and conditions implement RPM 2:
    a) The USACE or the permit applicant shall report all monitoring items, to include at minimum, the following:
        i. Pile maintenance: Report the final number of fender piles and treated timbers replaced and if any fish are observed to be injured or killed during pile maintenance.
        ii. Turbidity monitoring: Report if there is a 300-foot turbidity plume and the measures taken to correct the exceedance.
        iii. Wake stranding: Report the number of OGV calls to the Port if vessel calls exceed 400 vessels within a calendar year.
        iv. Please submit monitoring documents to projectreports.wcr@noaa.gov and include the NMFS tracking number (WCRO-2022-01443) in the subject line when the reports are submitted.

2.9. Conservation Recommendations

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

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

1) Prioritize maintenance to complete in-water work as soon as possible. If this is not possible, NMFS recommends in-water work is prioritized as noted below:
    a. Dock structure maintenance, fender pile replacement, and bank stabilization at the Berths.
    b. All work below the OHWM at Willow Grove.

2.10. Re-initiation of Consultation

This concludes formal consultation for the Port of Longview Routine Repair & Maintenance projects.

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

2.11. "Not Likely to Adversely Affect" Determinations

Green Sturgeon

We concur with the USACE's determination that the proposed action may affect, but is not likely to adversely affect green sturgeon because the species presence upstream of RM 50 is extremely rare (Moser & Lindley, 2007). Green sturgeon are only known to use estuary habitat for rearing during the summer and early fall months. Moser and Lindley (2007) note that commercial catch of green sturgeon in the CR estuary peaks in October, and records from other estuarine fisheries (Willapa Bay and Grays Harbor, Washington), which supports the idea that sturgeon are only present in these estuaries from June until October. Furthermore, green sturgeon are not susceptible to predation by avian or piscine predators due to the large size of sub-adult and adult fish and their benthic-oriented behavior, often at depths greater than -25 feet. The proposed action would occur within a small footprint, thus any reduction in benthic forage would not be biologically meaningful. Furthermore, the uppermost extent of green sturgeon critical habitat in the CR is approximately RM 50; therefore, the proposed action would have no direct effect on designated critical habitat for this species. However, we considered whether the continuation of OGV traffic through green sturgeon critical habitat could result in wake stranding of this species. We have determined that the chance of these vessels causing wake stranding is very low for green sturgeon due to their size and the effect of OGV traffic on green sturgeon is therefore insignificant.

Southern Resident killer whales

SRKWs could be indirectly affected by reducing availability of their primary prey species, Chinook salmon. The proposed activities are not expected to produce a measurable effect on the abundance, distribution, diversity, or productivity of Chinook salmon at either the population or species level. Given the total quantity of prey available to SRKWs throughout their range, this reduction in prey is extremely small. This conclusion is based on NMFS's previous analyses of the effects of in-river salmon harvest on SRKWs (e.g. WCRO-2017-7164). Due to the estimated reduction being so small, there is a low probability that any juvenile Chinook salmon killed by the proposed maintenance activities would have later (3–5 years) been intercepted by the killer whales across their vast range in the absence of the proposed activities. Therefore, the anticipated reduction of salmonids associated with the proposed action would result in an insignificant reduction in adult equivalent prey resources for SRKWs and an insignificant effect on their proposed critical habitat.

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

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

This analysis is based, in part, on the EFH assessment provided by the USACE and descriptions of EFH for Pacific Coast groundfish, coastal pelagic species (CPS), Pacific Coast salmon; and highly migratory species (HMS) contained in the fishery management plans developed by the PFMC and approved by the Secretary of Commerce (PFMC, 1998; 2005; 2007; 2014).

3.1. Essential Fish Habitat Affected by the Project

The proposed action may have an adverse effect on EFH designated for Pacific Coast salmon. The effects of the proposed action on EFH are the same as those described above in the ESA portion of this document. The action area includes areas designated as EFH for various life history stages of Chinook and coho salmon.

3.2. Adverse Effects on Essential Fish Habitat

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

1) Short-term decrease in water quality and benthic prey abundance due to increased suspended sediment caused by vibratory pile driving.
2) Short-term increase in underwater noise from fender pile removal and installation using a vibratory hammer.
3) Long-term altered migratory corridor and increased habitat for piscine predators due to the presence of in-water and over-water structures.

3.3. Essential Fish Habitat Conservation Recommendations

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

- Ensure the applicant or its contractor complies with applicable State water quality standards and implements corrective measures if temporary water quality standards are exceeded.
- Ensure that the applicant implements ESA Term and Condition 1.
- Ensure that the applicant implements ESA Term and Condition 2.

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

3.4. Statutory Response Requirement

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

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

3.5. Supplemental Consultation

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

4. DATA QUALITY ACT DOCUMENTATION AND PRE-DISSEMINATION REVIEW

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

4.1 Utility

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

4.2 Integrity

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

4.3 Objectivity

Information Product Category: Natural Resource Plan

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

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

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

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

5. REFERENCES

Agne, M. C., Beedlow, P. A., Shaw, D. C., Woodruff, D. R., Lee, E. H., Cline, S. P., & Comeleo, R. L. (2018). Interactions of predominant insects and diseases with climate change in Douglas-fir forests of western Oregon and Washington, USA. *Forest Ecology and Management, 409*, 317-332.

Alizadeh, M. R., Abatzoglou, J. T., Luce, C. H., Adamowski, J. F., Farid, A., & Sadegh, M. (2021). Warming enabled upslope advance in western US forest fires. *Proceedings of the National Academy of Sciences, 118*(22), e2009717118.

Anchor QEA, L. (2022). Port of Longview Routine Maintenance Actions: Biological Assessment. Longview, WA: Anchor QEA, LLC.

Anderson, J. J., Gurarie, E., & Zabel, R. W. (2005). Mean free-path length theory of predator–prey interactions: Application to juvenile salmon migration. *Ecological Modelling, 186*(2), 196-211.

Anderson, S. C., Moore, J. W., McClure, M. M., Dulvy, N. K., & Cooper, A. B. (2015). Portfolio conservation of metapopulations under climate change. *Ecological Applications*, *25*(2), 559-572.

Bauersfeld, K. (1977). *Effects of peaking (stranding) of Columbia River dams on juvenile anadromous fishes below the Dalles Dam, 1974 and 1975*: State of Washington, Department of Fisheries, Technical Report No. 31. Report to the U.S. Army Corps of Engineers, Contract DACW 57-74-C-0094. U. S. Army Corps of Engineers Portland District.

Beechie, T., Buhle, E., Ruckelshaus, M., Fullerton, A., & Holsinger, L. (2006). Hydrologic regime and the conservation of salmon life history diversity. *Biological conservation, 130*(4), 560-572.

Bisson, P. A., & Bilby, R. E. (1982). Avoidance of suspended sediment by juvenile coho salmon. *North American Journal of Fisheries Management*, *2*(4), 371-374.

Black, B. A., van der Sleen, P., Di Lorenzo, E., Griffin, D., Sydeman, W. J., Dunham, J. B., . . . Arismendi, I. (2018). Rising synchrony controls western North American ecosystems. *Global Change Biology*, *24*(6), 2305-2314.

Bottom, D. L., Baptista, A., Burke, J., Campbell, L., Casillas, E., Hinton, S., . . . Zamon, J. E. (2011). Estuarine Habitat and Juvenile Salmon: Current and Historical Linkages in the Lower Columbia River and Estuary, Final Report 2002-2008. In (pp. 216): Report of Research to US Army Corps of Engineers, Portland District, Contract W66QKZ20374382.

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

Braun, D. C., Moore, J. W., Candy, J., & Bailey, R. E. (2016). Population diversity in salmon: linkages among response, genetic and life history diversity. *Ecography, 39*(3), 317-328.

Burke, B. J., Peterson, W. T., Beckman, B. R., Morgan, C., Daly, E. A., & Litz, M. (2013). Multivariate models of adult Pacific salmon returns. *PLoS One, 8*(1), e54134.

Burke, J. L. (2004). Life histories of juvenile Chinook salmon in the Columbia River estuary: 1916 to the present. M.S. Thesis. *Oregon State University, Corvallis*.

Caltrans. (2015). Technical Guidance for Assessment and Mitigation of the Hydroacoustic Effects of Pile Driving on Fish. California Department of Transportation, Division of Environmental Analysis. (pp. 532).

Cannon, C. M. 2015. Landforms along the Lower Columbia River and the Influence of Humans. Portland State University. Pp. 133.

Carlson, T. J., Ploskey, G. R., Johnson, R., Mueller, R. P., Weiland, M. A., & Johnson, P. (2001). Observations of the behavior and distribution of fish in relation to the Columbia River navigation channel and channel maintenance activities. Pacific Northwest National Lab (PNNL), Richland, WA (United States).

Carr-Harris, C. N., Moore, J. W., Gottesfeld, A. S., Gordon, J. A., Shepert, W. M., Henry Jr, J. D., . . . Beacham, T. D. (2018). Phenological diversity of salmon smolt migration timing within a large watershed. *Transactions of the American Fisheries Society, 147*(5), 775-790.

Carrasquero, J. (2001). *Over-water structures: freshwater issues*: Washington Department of Fish and Wildlife.

Carter, J. A., McMichael, G. A., Welch, I. D., Harnish, R. A., & Bellgraph, B. J. (2009). Seasonal juvenile salmonid presence and migratory behavior in the lower Columbia River. PNNL-18246. *Pacific Northwest National Laboratory, Richland, Washington*.

Chasco, B., Burke, B., Crozier, L., & Zabel, R. (2021). Differential impacts of freshwater and marine covariates on wild and hatchery Chinook salmon marine survival. *PLoS One, 16*(2), e0246659.

Columbia Basin Research (CBR). (n.d.). Bonneville Dam Passage Data 10-year average. DART Adult Passage Historical Run Timing. Retrieved from http://www.cbr.washington.edu/dart/adult_hrt.html.

Cooper, M., Schaperow, J., Cooley, S., Alam, S., Smith, L., & Lettenmaier, D. (2018). Climate elasticity of low flows in the maritime western US mountains. *Water Resources Research, 54*(8), 5602-5619.

Crozier, L. (2015). Impacts of Climate Change on Columbia River Salmon: A review of the scientific literature published in 2014. Pages D1-D50 in Endangered Species Act Section 7(a)(2) supplemental biological opinion: consultation on remand for operation of the Federal Columbia River Power System. U.S. National Marine Fisheries Service, Northwest Region.

Crozier, L. (2016). Impacts of Climate Change on Columbia River Salmon: A review of the scientific literature published in 2015. Pages D1-D50 in Endangered Species Act Section 7(a)(2) supplemental biological opinion: consultation on remand for operation of the Federal Columbia River Power System. U.S. National Marine Fisheries Service, Northwest Region.

Crozier, L. (2017). Impacts of Climate Change on Columbia River Salmon: A review of the scientific literature published in 2016. Pages D1-D50 in Endangered Species Act Section 7(a)(2) supplemental biological opinion: consultation on remand for operation of the Federal Columbia River Power System. U.S. National Marine Fisheries Service, Northwest Region.

Crozier, L., & Siegel, J. E. (2018). Impacts of Climate Change on Columbia River Salmon: A review of the scientific literature published in 2017. Pages D1-D50 in Endangered Species Act Section 7(a)(2) supplemental biological opinion: consultation on remand for operation of the Federal Columbia River Power System. U.S. National Marine Fisheries Service, Northwest Region.

Crozier, L., & Zabel, R. W. (2006). Climate Impacts at Multiple Scales: Evidence for Differential Population Responses in Juvenile Chinook Salmon. *Journal of Animal Ecology, 75*(5), 1100-1109.

Crozier, L. G., McClure, M. M., Beechie, T., Bograd, S. J., Boughton, D. A., Carr, M., . . . Haltuch, M. A. (2019). Climate vulnerability assessment for Pacific salmon and steelhead in the California Current Large Marine Ecosystem. *PLoS One, 14*(7), e0217711.

Crozier, L. G., Siegel, J. E., Wiesebron, L. E., Trujillo, E. M., Burke, B. J., Sandford, B. P., & Widener, D. L. (2020). Snake River sockeye and Chinook salmon in a changing climate: Implications for upstream migration survival during recent extreme and future climates. *PLoS One, 15*(9), e0238886. doi:10.1371/journal.pone.0238886

Crozier, L. G., Zabel, R. W., Hockersmith, E. E., & Achord, S. (2010). Interacting effects of density and temperature on body size in multiple populations of Chinook salmon. *Journal of Animal Ecology, 79*(2), 342-349.

Davidson, J., Bebak, J., & Mazik, P. (2009). The effects of aquaculture production noise on the growth, condition factor, feed conversion, and survival of rainbow trout, Oncorhynchus mykiss. *Aquaculture*, *288*(3-4), 337-343.

Dawley, E. M., Ledgerwood, R. D., Blahm, T. H., Sims, C. W., Durkin, J. T., Kirn, R. A., . . . Ossiander, F. J. (1986). Migrational characteristics, biological observations, and relative survival of juvenile salmonids entering the Columbia River estuary, 1966-1983. US Department of Energy, Bonneville Power Administration, Division of Fish and Wildlife Portland, OR.

Dickey, P. 2003. Guide for Selecting Treated Wood. Prepared for the San Francisco Department of the Environment. Retrieved from https://sfapproved.org/.

Dornbusch, P., & Sihler, A. (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*.

Dorner, B., Catalano, M. J., & Peterman, R. M. (2018). Spatial and temporal patterns of covariation in productivity of Chinook salmon populations of the northeastern Pacific Ocean. *Canadian Journal of Fisheries and Aquatic Sciences*, *75*(7), 1082-1095.

Faler, M. P., Miller, L. M., & Welke, K. I. (1988). Effects of variation in flow on distributions of northern squawfish in the Columbia River below McNary Dam. *North American Journal of Fisheries Management*, *8*(1), 30-35.

Feist, B. E., Anderson, J. J., & Miyamoto, R. T. (1996). Potential impacts of pile driving on juvenile pink (*Oncorhynchus gorbuscha*) and chum (*O. keta*) salmon behavior and distribution.

FitzGerald, A. M., John, S. N., Apgar, T. M., Mantua, N. J., & Martin, B. T. (2021). Quantifying thermal exposure for migratory riverine species: phenology of Chinook salmon populations predicts thermal stress. *Global Change Biology*, *27*(3), 536-549.

Ford, M. J. (2022). Biological Viability Assessment Update for Pacific Salmon and Steelhead Listed Under the Endangered Species Act: Pacific Northwest. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-NWFSC-171.

FPL. 2001. Environmental impact of preservative-treated wood. USDA-Forest Service, Forest Products Laboratory. Madison, Wisconsin. http://www.fpl.fs.fed.us/documnts/techline/environmental-impact-of-preservativetreated-wood.pdf.

Freshwater, C., Anderson, S. C., Holt, K. R., Huang, A.-M., & Holt, C. A. (2019). Weakened portfolio effects constrain management effectiveness for population aggregates. *Ecological Applications*, *29*(7), e01966.

Gliwicz, Z. M., Babkiewicz, E., Kumar, R., Kunjiappan, S., & Leniowski, K. (2018). Warming increases the number of apparent prey in reaction field volume of zooplanktivorous fish. *Limnology and Oceanography, 63*(S1), S30-S43.

Gosselin, J. L., Buhle, E. R., Van Holmes, C., Beer, W. N., Iltis, S., & Anderson, J. J. (2021). Role of carryover effects in conservation of wild Pacific salmon migrating regulated rivers. *Ecosphere*, *12*(7), e03618.

Gourtay, C., Chabot, D., Audet, C., Le Delliou, H., Quazuguel, P., Claireaux, G., & Zambonino-Infante, J.-L. (2018). Will global warming affect the functional need for essential fatty acids in juvenile sea bass (Dicentrarchus labrax)? A first overview of the consequences of lower availability of nutritional fatty acids on growth performance. *Marine Biology, 165*(9), 143.

Grette, G. (1985). Fish monitoring during pile driving at Hiram H. Chittenden Locks, August-September 1985. Seattle District Army Corps of Engineers. Evans-Hamilton.

Groot, C., & Margolis, L. (1991). *Pacific salmon life histories*. Vancouver, Canada: UBC press.

Halofsky, J. E., Peterson, D. L., & Harvey, B. J. (2020). Changing wildfire, changing forests: the effects of climate change on fire regimes and vegetation in the Pacific Northwest, USA. *Fire Ecology, 16*(1), 1-26.

Halofsky, J. S., Conklin, D. R., Donato, D. C., Halofsky, J. E., & Kim, J. B. (2018). Climate change, wildfire, and vegetation shifts in a high-inertia forest landscape: Western Washington, USA. *PLoS One, 13*(12), e0209490.

Handegard, N. O., Michalsen, K., and Tjostheim, D. 2003. Avoidance behavior in cod (Gadus morhua) to a bottom-trawling vessel. Aquatic Living Resources 16(2003), 265-270.

Hawkins, A., Popper, A., Fay, R., Mann, D., Bartol, S., Carlson, T., . . . Halvorsen, M. (2014). Sound Exposure Guidelines for Fishes and Sea Turtles: A Technical Report. In: Springer and ASA Press, Cham, Switzerland.

Healey, M. (2011). The cumulative impacts of climate change on Fraser River sockeye salmon (Oncorhynchus nerka) and implications for management. *Canadian Journal of Fisheries and Aquatic Sciences, 68*(4), 718-737.

Hering, D. K., Bottom, D. L., Prentice, E. F., Jones, K. K., & Fleming, I. A. (2010). Tidal movements and residency of subyearling Chinook salmon (Oncorhynchus tshawytscha) in an Oregon salt marsh channel. *Canadian Journal of Fisheries and Aquatic Sciences, 67*(3), 524-533.

Herring, S. C., Christidis, N., Hoell, A., Kossin, J. P., Schreck III, C. J., & Stott, P. A. (2018). Explaining extreme events of 2016 from a climate perspective. *Bulletin of the American Meteorological Society, 99*(1), S1-S157.

Hingston, J.A., Collins, C.D., Murphy, R.J. and Lester, J.N., 2001. Leaching of chromated copper arsenate wood preservatives: a review. Environmental Pollution, 111(1), pp.53-66.

Holden, Z. A., Swanson, A., Luce, C. H., Jolly, W. M., Maneta, M., Oyler, J. W., . . . Affleck, D. (2018). Decreasing fire season precipitation increased recent western US forest wildfire activity. *Proceedings of the National Academy of Sciences, 115*(36), E8349-E8357.

Holsman, K. K., Scheuerell, M. D., Buhle, E., & Emmett, R. (2012). Interacting effects of translocation, artificial propagation, and environmental conditions on the marine survival of Chinook Salmon from the Columbia River, Washington, USA. *Conservation Biology, 26*(5), 912-922.

Holton, R. L. 1984. Benthic Infauna of the Columbia River Estuary. Final Report on the Benthic Infauna Work Unit of the Columbia River Estuary Data Development Program. Corvallis, OR. pp. 218.

Howell, M. D., & Uusitalo, N. (2000). *Eulachon (Thaleichthys pacificus) studies related to lower Columbia river channel deepening operations*: Oregon Department of Fish and Wildlife.

Intergovernmental Panel on Climate Change (IPCC) Working Group I (WGI), I. P. o. C. C. W. G. (2021). Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. In P. Z. V. Masson-Delmotte, A. Pirani, S. L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M. I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J.B.R. Matthews, T. K. Maycock, T. Waterfield, O. Yelekçi, R. Yu and B. Zhou (Ed.): Cambridge University Press.

IPCC Working Group II (WGII). (2022). Climate Change 2022: Impacts, Adaptation and Vulnerability: Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. In D. C. R. H.O. Pörtner, M. Tignor, E.S. Poloczanska, K. Mintenbeck, A. Alegría, M. Craig, S. Langsdorf, S. Löschke, V. Möller, A. Okem, and B. Rama (Ed.): Cambridge University Press.

Isaak, D. J., & Bjornn, T. C. (1996). Movement of northern squawfish in the tailrace of a lower Snake River dam relative to the migration of juvenile anadromous salmonids. *Transactions of the American Fisheries Society, 125*(5), 780-793.

Isaak, D. J., Luce, C. H., Horan, D. L., Chandler, G. L., Wollrab, S. P., & Nagel, D. E. (2018). Global warming of salmon and trout rivers in the Northwestern US: road to ruin or path through purgatory? *Transactions of the American Fisheries Society, 147*(3), 566-587.

Ivanova, S. V., Kessel, S. T., Espinoza, M., McLean, M. F., O'Neill, C., Landry, J., Hussey, R.W., Vagle, S., and Fisk, A. T. 2019. Shipping alters the movement and behavior of Arctic cod (*Boreogadus saida*), a keystone fish in Arctic marine ecosystems. Ecological Applications 30(3). https://doi.org/10.1002/eap.2050

Jacox, M. G., Alexander, M. A., Mantua, N. J., Scott, J. D., Hervieux, G., Webb, R. S., & Werner, F. E. (2018). Forcing of multi-year extreme ocean temperatures that impacted California Current living marine resources in 2016. *Bulletin of the American Meteorological Society*, *99*(1).

Johnson, B. M., Kemp, B. M., & Thorgaard, G. H. (2018). Increased mitochondrial DNA diversity in ancient Columbia River basin Chinook salmon Oncorhynchus tshawytscha. *PLoS One*, *13*(1), e0190059.

Johnson, E. L., Clabough, T. S., Bennett, D. H., Bjornn, T. C., Peery, C. A., Caudill, C. C., & Stuehrenberg, L. C. (2005). Migration depths of adult spring and summer Chinook salmon in the lower Columbia and Snake rivers in relation to dissolved gas supersaturation. *Transactions of the American Fisheries Society*, *134*(5), 1213-1227.

Keefer, M. L., Clabough, T. S., Jepson, M. A., Johnson, E. L., Peery, C. A., & Caudill, C. C. (2018). Thermal exposure of adult Chinook salmon and steelhead: Diverse behavioral strategies in a large and warming river system. *PLoS One*, *13*(9), e0204274.

Kelty, R., and S. Bliven. 2003. Environmental and aesthetic impacts of small docks and piers workshop report: Developing a science-based decision support tool for small dock management, phase 1: Status of the science. In Decision Analysis Series No. 22. N.C.O. Program, editor.

Kilduff, D. P., Botsford, L. W., & Teo, S. L. (2014). Spatial and temporal covariability in early ocean survival of Chinook salmon (Oncorhynchus tshawytscha) along the west coast of North America. *ICES Journal of Marine Science, 71*(7), 1671-1682.

Koontz, E. D., Steel, E. A., & Olden, J. D. (2018). Stream thermal responses to wildfire in the Pacific Northwest. *Freshwater Science, 37*(4), 731-746.

Krosby, M., Theobald, D. M., Norheim, R., & McRae, B. H. (2018). Identifying riparian climate corridors to inform climate adaptation planning. *PLoS One*, *13*(11), e0205156.

Lebow, S. 2004. Alternatives to chromated copper arsenate (CCA) for residential construction. USDA-Forest Service, Forests Products Laboratory.Research Paper. FPL-RP-618.

Lebow, S. T. and Tippie, M., 2001. Guide for minimizing the effect of preservative-treated wood on sensitive environments. Gen. Tech. Rep. FPL–GTR–122. Madison, WI: US Department of Agriculture, Forest Service, Forest Products Laboratory. 18 p., 122.

Lindley, S. T., Grimes, C. B., Mohr, M. S., & Peterson, W. (2009). What caused the Sacramento River fall Chinook stock collapse. *NOAA Tech Memo NMFS-SWFSC, 447*.

Lower Columbia River Estuary Partnership (LCREP). (2023). Mission Accomplishments. Retrieved from https://www.estuarypartnership.org/who-we-are/mission-accomplishments.

Malek, K., Adam, J. C., Stöckle, C. O., & Peters, R. T. (2018). Climate change reduces water availability for agriculture by decreasing non-evaporative irrigation losses. *Journal of Hydrology, 561*, 444-460.

Martinelli, T. L., & Shively, R. S. (1997). Seasonal distribution, movements and habitat associations of northern squawfish in two lower Columbia River reservoirs. *Regulated Rivers: Research & Management: An International Journal Devoted to River Research and Management, 13*(6), 543-556.

McNatt, R. A., Bottom, D. L., & Hinton, S. A. (2016). Residency and movement of juvenile Chinook salmon at multiple spatial scales in a tidal marsh of the Columbia River estuary. *Transactions of the American Fisheries Society, 145*(4), 774-785.

Moser, M. L., & Lindley, S. T. (2007). Use of Washington estuaries by subadult and adult green sturgeon. *Environmental Biology of Fishes, 79*, 243-253.

Munsch, S. H., Greene, C. M., Mantua, N. J., & Satterthwaite, W. H. (2022). One hundred-seventy years of stressors erode salmon fishery climate resilience in California's warming landscape. *Global Change Biology, 28*(7), 2183-2201.

Myers, J. M., Jorgensen, J., Sorel, M., Bond, M., Nodine, T., & Zabel, R. (2018). Upper WillametteRiver Life Cycle Modeling and the Potential Effects of Climate Change. Draft Report to the U.S. Army Corps of Engineers. Northwest Fisheries Science Center.

Nedwell, J., & Edwards, B. (2002). Measurements of underwater noise in the Arun River during piling at County Wharf, Littlehampton. *Report by Subacoustech, Ltd. to David Wilson Homes Ltd*.

Newcombe, C. P., & Jensen, J. O. (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.

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

Nichols, T. A., Anderson, T. W., & Širović, A. (2015). Intermittent noise induces physiological stress in a coastal marine fish. PLoS One, 10(9), e0139157.

NMFS. (2008). Endangered Species Act – Section 7 Formal Consultation and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Consultation for the Port of Portland's Fender Pile Maintenance Program at T2, 4, 5, and 6, Willamette River/Columbia River HUC, Multnomah County, Oregon (COE No. 200500426). *NOAA's NMFS Northwest Region*.

NMFS. (2009). Middle Columbia River steelhead distinct population segment ESA recovery plan. National Marine Fisheries Service, West Coast Region.

NMFS. (2011). 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.

NMFS. (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.

NMFS. (2015). ESA Recovery Plan for Snake River Sockeye Salmon. West Coast Region, Protected Resources Division, Portland, OR.

NMFS. (2016). Proposed ESA Recovery Plan for Snake River Spring/Summer Chinook Salmon and Snake River Steelhead. West Coast Region, Protected Resources Division, Portland, OR.

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

NMFS. (2017b). Presence of ESA-listed fish species in the Lower Columbia River by life stage. Northwest Fisheries Science Center and NMFS Protected Resources Division.

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

NMFS. (2018). Recovery Plan for the Southern Distinct Population Segment of North American Green Sturgeon (*Acipenser medirostris*). National Marine Fisheries Service, Sacramento, CA.

NMFS. (2021). Southern Distinct Population Segment of North American Green Sturgeon (*Acipenser medirostris*) 5-Year Review: Summary and Evaluation. National Marine Fisheries Service, Sacramento, CA.

NMFS. (2022a). 2022 5-Year Review: Summary & Evaluation of Lower Columbia River Chinook Salmon, Columbia River Chum Salmon, Lower Columbia River Coho Salmon, and Lower Columbia River Steelhead. Retrieved from https://www.fisheries.noaa.gov/resource/document/2022-5-year-review-summaryevaluation-lower-columbia-river-chinook-salmon.

NMFS. (2022b). 2022 5-Year Review: Summary & Evaluation of Upper Columbia River Spring-run Chinook Salmon and Upper Columbia River Steelhead. doi:https://doi.org/10.25923/p4w5-dp31

NMFS. (2022c). 2022 5-Year Review: Summary & Evaluation of Snake River Spring/Summer Chinook Salmon. doi:https://doi.org/10.25923/a3ay-dw78

NMFS. (2022d). 2022 5-Year Review: Summary & Evaluation of Snake River Fall-Run Chinook Salmon. West Coast Region. doi:https://doi.org/10.25923/vgh6-g225

NMFS. (2022f). 2022 5-Year Review: Summary & Evaluation of Snake River Sockeye Salmon. doi:https://doi.org/10.25923/q1s6-3g66

NMFS. (2022h). 2022 5-Year Review: Summary & Evaluation of Middle Columbia River Steelhead. doi:https://doi.org/10.25923/63dr-dw24

NMFS. (2022i). 2022 5-Year Review: Summary & Evaluation of Snake River Basin Steelhead. doi:https://doi.org/10.25923/pxax-h320

NMFS. (2022j). 2022 5-Year Review: Summary & Evaluation of Eulachon, Southern DPS. Retrieved from https://www.fisheries.noaa.gov/resource/document/2022-5-year-reviewsummary-evaluation-eulachon-southern-dps.

NOAA National Centers for Environmental Information (NCEI). (2022). State of the Climate: Global Climate Report for Annual 2021. Retrieved from https://www.ncdc.noaa.gov/sotc/global/202113.

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

Ohlberger, J., Ward, E. J., Schindler, D. E., & Lewis, B. (2018). Demographic changes in Chinook salmon across the Northeast Pacific Ocean. *Fish and Fisheries, 19*(3), 533-546.

Olmos, M., Payne, M. R., Nevoux, M., Prévost, E., Chaput, G., Du Pontavice, H., . . . Rivot, E. (2020). Spatial synchrony in the response of a long range migratory species (Salmo salar) to climate change in the North Atlantic Ocean. *Global Change Biology, 26*(3), 1319-1337.

Oregon Department of Fish and Wildlife (ODFW) & NMFS. (2011). Upper Willamette River conservation and recovery plan for Chinook salmon and steelhead. Oregon Department of Fish and Wildlife and National Marine Fisheries Service, Northwest Region.

Ou, M., Hamilton, T. J., Eom, J., Lyall, E. M., Gallup, J., Jiang, A., . . . Brauner, C. J. (2015). Responses of pink salmon to CO2-induced aquatic acidification. *Nature Climate Change, 5*(10), 950-955.

Parente, W. D., & Snyder, G. R. (1970). A pictorial record of the hatching and early development of the eulachon (*Thaleichthys pacificus*). *Northwest Science*, *44*(1), 50-57.

Pearson, W. H., Skalski, J., Sobocinski, K. L., Miller, M. C., Johnson, G. E., Williams, G. D., . . . Buchanan, R. A. (2006). *A Study of Stranding of Juvenile Salmon by Ship Wakes Along the Lower Columbia River Using a Before-and-After Design: Before-Phase Results*.

Pearson, W. H., & Skalski, J. R. (2011). Factors affecting stranding of juvenile salmonids by wakes from ship passage in the Lower Columbia River. *River research and applications, 27*(7), 926-936.

Pacific Fishery Management Council (PFMC). (1998). Description and identification of essential fish habitat for the Coastal Pelagic Species Fishery Management Plan. Appendix D to Amendment 8 to the Coastal Pelagic Species Fishery Management Plan. Pacific Fishery Management Council, Portland, Oregon.

PFMC. (2005). Amendment 18 (bycatch mitigation program), Amendment 19 (essential fish habitat) to the Pacific Coast Groundfish Fishery Management Plan for the California, Oregon, and Washington groundfish fishery. Pacific Fishery Management Council, Portland, Oregon.

PFMC. (2007). U.S. West Coast highly migratory species: Life history accounts and essential fish habitat descriptions. Appendix F to the Fishery Management Plan for the U.S. West Coast Fisheries for Highly Migratory Species. Pacific Fishery Management Council, Portland, Oregon.

PFMC. (2008). Management of krill as an essential component of the California Current ecosystem. Amendment 12 to the Coastal Pelagic Species Fishery Management Plan. Environmental assessment, regulatory impact review & regulatory flexibility analysis. Pacific Fishery Management Council, Portland, Oregon.

PFMC. (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. Pacific Fishery Management Council, Portland, Oregon.

Popper, A. N., & Hastings, M. (2009). The effects of anthropogenic sources of sound on fishes. *Journal of fish biology*, *75*(3), 455-489.

Poston, Ted. 2001. Treated Wood Issues Associated with Overwater Structures in Marine and Freshwater Environments. White Paper submitted to WDFW, DOE, WADOT.

Pribyl, A. L., Vile, J. S., & Friesen, T. A. (2005). Population structure, movement, habitat use, and diet of resident piscivorous fishes in the lower Willamette River. *Biology, behavior, and resources of resident and anadromous fish in the lower Willamette River*, 139.

Quinn, T. P. (1988). Estimated swimming speeds of migrating adult sockeye salmon. *Canadian Journal of Zoology, 66*(10), 2160-2163.

Quinn, T. P. (2018). The behavior and ecology of Pacific salmon and trout. In (2 ed., pp. 70): University of Washington press.

Rich, W. H. (1920). *Early history and seaward migration of Chinook salmon in the Columbia and Sacramento rivers*: US Government Printing Office.

Rondorf, D. W., Rutz, G. L., & Charrier, J. C. (2010). Minimizing effects of over-water docks on federally listed fish stocks in McNary Reservoir: a literature review for criteria.

Ruggerone, G., Goodman, S., & Miner, R. (2008). Behavioral response and survival of juvenile coho salmon exposed to pile driving sounds. Prepared for the Port of Seattle by Natural Resource Consultants. *Inc. Seattle, WA.*

Sagerman, J., Hansen, J. P., and Wilkstrom, S. A. 2019. Effects of boat traffic and mooring infrastructure on aquatic vegetation: A systematic review and meta-analysis. Ambio 49, 517-530.

Schindler, D. E., Armstrong, J. B., & Reed, T. E. (2015). The portfolio concept in ecology and evolution. *Frontiers in Ecology and the Environment, 13*(5), 257-263.

Servizi, J. A., & Martens, D. W. (1991). Effect of temperature, season, and fish size on acute lethality of suspended sediments to coho salmon (Oncorhynchus kisutch). *Canadian Journal of Fisheries and Aquatic Sciences, 48*(3), 493-497.

Servizi, J. A., & Martens, D. W. (1992). Sublethal responses of coho salmon (Oncorhynchus kisutch) to suspended sediments. *Canadian Journal of Fisheries and Aquatic Sciences, 49*(7), 1389-1395.

Siegel, J. E., & Crozier, L. (2019). Impacts of Climate Change on Salmon of the Pacific Northwest. A review of the scientific literature published in 2018. In: Fish Ecology Division, NWFSC.

Siegel, J. E., & Crozier, L. G. (2020). Impacts of Climate Change on Salmon of the Pacific Northwest: A review of the scientific literature published in 2019. In: National Marine Fisheries Service, Northwest Fisheries Science Center, Fish Ecology Division.

Simenstad, C. A. (1990). Effects of dredging on anadromous Pacific Coast fishes : workshop proceedings, Seattle, Washington, September 8-9, 1988. Retrieved from https://repository.library.noaa.gov/view/noaa/39297.

Simpson, S. D., Radford, A.N., Nedelec, S. L., Ferrari, M. C. O., Chivers, D. P., McCormick, M. I., and Meekan, M. G. 2016. Nature Communications, 7(2016), 10544.

Smith, W. E., & Saalfeld, R. W. (1955). Studies on Columbia River smelt Thaleichthys pacificus (Richardson). *Fisheries Research Papers, 1*(3), 2-23.

Sridhar, V., Billah, M. M., & Hildreth, J. W. (2018). Coupled surface and groundwater hydrological modeling in a changing climate. *Groundwater, 56*(4), 618-635.

Stachura, M. M., Mantua, N. J., & Scheuerell, M. D. (2014). Oceanographic influences on patterns in North Pacific salmon abundance. *Canadian Journal of Fisheries and Aquatic Sciences, 71*(2), 226-235.

Sturrock, A. M., Carlson, S. M., Wikert, J. D., Heyne, T., Nusslé, S., Merz, J. E., . . . Johnson, R. C. (2020). Unnatural selection of salmon life histories in a modified riverscape. *Global Change Biology, 26*(3), 1235-1247.

Tabor, R. A., Shively, R. S., & Poe, T. P. (1993). Predation on juvenile salmonids by smallmouth bass and northern squawfish in the Columbia River near Richland, Washington. *North American Journal of Fisheries Management, 13*(4), 831-838.

Thorne, K., MacDonald, G., Guntenspergen, G., Ambrose, R., Buffington, K., Dugger, B., . . . Rosencranz, J. (2018). US Pacific coastal wetland resilience and vulnerability to sea-level rise. *Science Advances, 4*(2), eaao3270.

Upper Columbia Salmon Recovery Board (UCSRB). (2007). Upper Columbia spring Chinook salmon and steelhead recovery plan. US Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service.

U.S. Army Corp of Engineers (USACE). (2017). Memorandum for: Portland District, Regulatory Branch (CENWP-OD-G, Chang), Regulatory File Nos. NWP-2000-039/4 and NWP-2015-332. Subject: Portland Sediment Evaluation Team (PSET) Level 2 dredged material suitability determination for maintenance dredging at two Port of Longview's (Port's) facilities in Longview, Cowlitz County, Washington: Port's berthing areas (Berths 1,2, and 4-9) on the Columbia River at river mile (RM) 66; and the Port's Willow Grove Boat Basin on the Columbia River at RM 60. In J. Holm (Ed.): USACE PSET.

U.S. Department of Commerce (USDC). (2009). Endangered and threatened wildlife and plants: final rulemaking to designate critical habitat for the threatened southern distinct population segment of North American green sturgeon. U.S. Department of Commerce, National Marine Fisheries Service. Federal Register 74(195):52300-52351.

USDC. (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.

U.S. Environmental Protection Agency (USEPA). (2007). Best Management Practices For Pile Removal & Disposal (White Paper). pp. 4.

Vabo, R., Olsen, K., and Huse, I. 2001. The effect of vessel avoidance of wintering Norwegian spring spawning herring. Fisheries Research 58 (2002), 59-77.

Van der Knapp, I., Reubens, J., Thomas, L., Ainslie, M.A., Winter, H.V., Hubert, J., Martin, B., and Slabbekoorn, H. 2021. Effects of a seismic survey on movement of free-ranging Atlantic cod. Current Biology 31(7), 1555-1562.

Veilleux, H. D., Donelson, J. M., & Munday, P. L. (2018). Reproductive gene expression in a coral reef fish exposed to increasing temperature across generations. *Conservation physiology, 6*(1), cox077.

Wainwright, T. C., & Weitkamp, L. A. (2013). Effects of Climate Change on Oregon Coast Coho Salmon: Habitat and Life-Cycle Interactions. *Northwest Science, 87*(3), 219-242, 224.

Ward, E. J., Anderson, J. H., Beechie, T. J., Pess, G. R., & Ford, M. J. (2015). Increasing hydrologic variability threatens depleted anadromous fish populations. *Global Change Biology, 21*(7), 2500-2509.

Washington State Department of Ecology (Ecology). (2022). Water Quality Atlas Map. Retrieved from https://apps.ecology.wa.gov/waterqualityatlas/wqa/map.

Washington State Department of Transport (WSDOT). (2011). Port Townsend Dolphin Timber Pile Removal–Vibratory Pile Monitoring Technical Memorandum. January 3, 2011.

Weis, J. S. and Weis, P., 1996. The effects of using wood treated with chromated copper arsenate in shallow-water environments: a review. Estuaries, 19(2), pp.306-310.

Weston Solutions. (2006). Jimmycomelately Piling Removal Monitoring Project, Final Report. In (pp. 109). Port Townsend, Washington: Prepared for Jamestown S'Klallam Tribe.

Williams, C. R., Dittman, A. H., McElhany, P., Busch, D. S., Maher, M. T., Bammler, T. K., . . . Gallagher, E. P. (2019). Elevated CO2 impairs olfactory-mediated neural and behavioral responses and gene expression in ocean-phase coho salmon (Oncorhynchus kisutch). *Global Change Biology, 25*(3), 963-977.

Williams, T. H., Spence, B. C., Boughton, D. A., Johnson, R. C., Crozier, E. G. R., Mantua, N. J., . . . Lindley, S. T. (2016). Viability assessment for Pacific salmon and steelhead listed under the Endangered Species Act: Southwest. In (Vol. U.S. Dep Commerce NOAA Tech Memo NMFS SWFSC 564). Santa Cruz, CA: NOAA Fisheries Southwest Fisheries Science Center.

Willson, M. F., Armstrong, R. H., Hermans, M., & Koski, K. V. (2006). Eulachon: A review of biology and an annotated bibliography. *Alaska Fisheries Science Center, Processed Report 2006-12.*

WSDOT. (2020). 7.0 Construction Noise Impact Assessment. In *Biological Assessment (BA) Preparation Manual*.

Wysocki, L. E., Dittami, J. P., & Ladich, F. (2006). Ship noise and cortisol secretion in European freshwater fishes. *Biological conservation, 128*(4), 501-508.

Yan, H., Sun, N., Fullerton, A., & Baerwalde, M. (2021). Greater vulnerability of snowmelt-fed river thermal regimes to a warming climate. *Environmental Research Letters, 16*(5), 054006.

6. APPENDIX

Table A1. Presence of ESA-listed Fish species in the LCR by life stage.

	░	Present							▒	Abundant							█	Peak Abundance						
Species	**Jan**		**Feb**		**Mar**		**Apr**		**May**		**June**		**July**		**Aug**		**Sept**		**Oct**		**Nov**		**Dec**	
LCR Chinook																								
Adult (migrating and holding)							▒	█	█	█	█	█				░	█	█	█	█				
Juvenile (emigration)				░	░	░	▒	█	█	█	█	▒					▒	▒	▒	▒	▒	▒	▒	▒
UCR Spring Chinook																								
Adult (migration)							░	▒	█	█	█	▒	▒	▒	▒	▒	░	░	░					
Juvenile (emigration)								▒	█	█	█	▒	▒	░	░	░								
UWR Spring Chinook																								
Adult (migration)		░	░	░	░	░	▒	▒	█	█	█	█	█	░	░	░								
Juvenile (emigration)	░	░	░	░	░	░							░	░						░	░	░	░	░
SR Spring/Summer Chinook																								
Adult (migration)				░	░	░	░	▒	█	█	█	█	█	█	█	▒	░	░						
Juvenile (emigration)								░	█	█	█	░	░	░										
SR Fall Chinook																								
Adult migration)								░	░	░	░	░	░	░	░	█	█	█	▒	░	░	░		
Juvenile (emigration)		░	░	░	░	░	░	█	█	█	█	█	█	▒	▒	░	░	░	░	░	░	░	░	░
LC Chum																								
Adult (migration)																		░	▒	▒	█	█	█	█
Adult (spawning)																		░	░	▒	█	█		
Juvenile (emigration)		░	░	░	▒	▒	█	█	█	░	░	░	░											

░ Present ▒ Abundant █ Peak Abundance

Species	**Jan**		**Feb**		**Mar**		**Apr**		**May**		**June**		**July**		**Aug**		**Sept**		**Oct**		**Nov**		**Dec**	
LCR Coho																								
Adult (migration)															█	█	█	█	█	█	█	▒		
Adult(spawning)																					█	█		
Juvenile(rearing)	░	░	░	░	░	░	█	█	█	█	█	░	░	░	░	░	░	░	░	░	░	░	░	░
Juvenile(emigration)					░	░	█	█	█	█	▒	░												
SR Sockeye																								
Adult (migration)									░	░	▒	█	█	▒	░									
Juvenile(emigration)							░	░	▒	▒	█	█												
LCR Steelhead																								
Adult (migration)	▒	▒	▒	▒	█	█	█	█	▒	▒	▒	█	█	█	█	█	░	░	░	░	░	░	░	░
Juvenile(emigration)				░	░	░	░	░	█	█	█	░	░	░	░	░	░	░	░	░	░	░	░	░
MCR Steelhead																								
Adult (migration)							█	█	█	█	█	█	█	░	░									
Juvenile (emigration)			░	░	░	░	░	▒	▒	█	█	█	▒	░										
UCR steelhead																								
Adult (migration)	░	░	░	░	▒	▒	▒	▒	▒	░	░	░	▒	█	█	█	█	▒	▒	▒	▒	░		
Juvenile (emigration)							░	░	█	█	█	░	░	░										
UWR Summer Steelhead																								
Adult (migration)				░	░	░	▒	█	█	█	█	█	█	▒	▒	░	░	░	░	░				
UWR Winter Steelhead																								
Adult (migration)	░	░	░	░	▒	▒	▒	▒	▒	░	░	░	░								░	░	░	░
SRB Steelhead																								
Adult (migration)																								
Juvenile (emigration)							▒	█	█	█	█	▒												
SDPS Eulachon																								
Adult (migration)	█	█	█	█	█	█	░	░	░	░	░	░									░	░	░	█
Adult (spawning)	█	█	█	█	█	█	▒	▒	▒	▒	▒	▒									░	░	░	░
larvae emigration	▒	▒	█	█	█	█	█	█	▒	▒	▒	▒	▒	▒							░	░	░	░
SDPS Green Sturgeon																								
Sub-adult and adult foraging										▒	█	█	█	█	█	█	▒							