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

Refer to NMFS No:
WCRO-2021-01428

August 17, 2023

Todd Tillinger
Chief, Regulatory Branch
U.S. Army Corps of Engineers, Seattle District
4735 East Marginal Way South, Bldg. 1202
Seattle, Washington 98134-2388

Re: Endangered Species Act Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response for Seattle Parks and Recreation's Leschi South Marina Wave Attenuator and Public Access Facility Improvements Project, King County, Washington (USACE No. NWS-2021-486-WRD, HUC: 171100120400 – Lake Washington)

Dear Mr. Tillinger:

Thank you for your letter of June 11, 2021, 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 Seattle Parks and Recreation's Leschi South Marina Wave Attenuator and Public Access Facility Improvements project on Lake Washington. Thank you, also, for your request for consultation pursuant to the essential fish habitat (EFH) provisions in Section 305(b) of the Magnuson–Stevens Fishery Conservation and Management Act [16 U.S.C. 1855(b)] for this action.

The enclosed document contains the biological opinion (opinion) prepared by the NMFS pursuant to section 7 of the ESA on the effects of the proposed action. In this opinion, the NMFS concludes that the proposed action would adversely affect but is not likely to jeopardize the continued existence of Puget Sound (PS) Chinook salmon and PS steelhead. The NMFS also concludes that the proposed action is likely to adversely affect designated critical habitat for PS Chinook salmon, but is not likely to result in the destruction or adverse modification of that designated critical habitat. This opinion also documents our conclusion that the proposed action is not likely to adversely affect southern resident (SR) killer whales and their designated critical habitat.

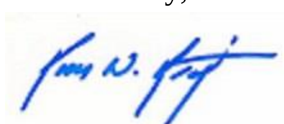
This opinion includes an incidental take statement (ITS) that describes reasonable and prudent measures (RPMs) the NMFS considers necessary or appropriate to minimize the incidental take associated with this action, and sets forth nondiscretionary terms and conditions that the USACE must comply with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

Section 3 of this document includes our analysis of the action's likely effects on EFH pursuant to Section 305(b) of the MSA. Based on that analysis, the NMFS concluded that the action would adversely affect designated freshwater EFH for Pacific Coast Salmon. Therefore, we have provided 1 conservation recommendation that can be taken by the USACE to avoid, minimize, or otherwise offset potential adverse effects on EFH. We also concluded that the action would not adversely affect EFH for Pacific Coast groundfish and coastal pelagic species. Therefore, consultation under the MSA is not required for those EFHs.

Section 305(b) (4) (B) of the MSA requires Federal agencies to provide a detailed written response to the NMFS within 30 days after receiving this recommendation. 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 recommendations. In response to increased oversight of overall EFH program effectiveness by the Office of Management and Budget, NMFS established a quarterly reporting requirement to determine how many conservation recommendations are provided as part of each EFH consultation and how many are adopted by the action agency. Therefore, we request that in your statutory reply to the EFH portion of this consultation you clearly identify the number of conservation recommendations accepted.

Please contact Donald Hubner in the North Puget Sound Branch of the Oregon/Washington Coastal Office at (206) 526-4359, or by electronic mail at Donald.Hubner@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: Jacalen Printz, 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

Seattle Parks and Recreation's Leschi South Marina
Wave Attenuator and Public Access Facility Improvements, King County, Washington
(USACE No. NWS-2021-486-WRD, HUC: 171100120400)

NMFS Consultation Number: WCRO-2021-01428

Action Agencies: U.S. Army Corps of Engineers

Affected Species and NMFS' Determinations:

ESA-Listed Species	**Status**	**Is Action Likely to Adversely Affect Species?**	**Is Action Likely To Jeopardize the Species?**	**Is Action Likely to Adversely Affect Critical Habitat?**	**Is Action Likely To Destroy or Adversely Modify Critical Habitat?**
Chinook salmon (*Oncorhynchus tshawytscha*) Puget Sound (PS)	Threatened	Yes	No	Yes	No
Steelhead (*O. mykiss*) PS	Threatened	Yes	No	N/A	N/A
killer whales (*Orcinus orca*) Southern resident (SR)	Endangered	No	No	No	No

Affected Essential Fish Habitat (EFH) and NMFS' Determinations:

Fishery Management Plan That Describes EFH in the Project Area	**Does Action Have an Adverse Effect on EFH?**	**Are EFH Conservation Recommendations Provided?**
Pacific Coast Salmon	Yes	Yes
Pacific Coast Groundfish	No	No
Coastal Pelagic Species	No	No

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: August 17, 2023

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LIST OF ABBREIVIATIONS

BE – Biological Evaluation
BMP – Best Management Practices
CFR – Code of Federal Regulations
dB – Decibel (common unit of measure for sound intensity)
DIP – Demographically Independent Population
DPS – Distinct Population Segment
DQA – Data Quality Act
EF – Essential Feature
EFH – Essential Fish Habitat
ESA – Endangered Species Act
ESU – Evolutionarily Significant Unit
FR – Federal Register
FMP – Fishery Management Plan
HAPC – Habitat Area of Particular Concern
HUC – Hydrologic Unit Code
HPA – Hydraulic Project Approval
ITS – Incidental Take Statement
JARPA – Joint Aquatic Resource Permit Application
mg/L – Milligrams per Liter
MPG – Major Population Group
MSA – Magnuson-Stevens Fishery Conservation and Management Act
NMFS – National Marine Fisheries Service
NOAA – National Oceanic and Atmospheric Administration
NTU – Nephlometric Turbidity Units
OHWM – Ordinary High-Water Mark
PAH – Polycyclic Aromatic Hydrocarbon
PBF – Physical or Biological Feature
PCB- Polychlorinated Biphenyl
PFMC – Pacific Fishery Management Council
PS – Puget Sound
PSTRT – Puget Sound Technical Recovery Team
PSSTRT – Puget Sound Steelhead Technical Recovery Team
RL – Received Level
RPA – Reasonable and Prudent Alternative
RPM – Reasonable and Prudent Measure
SAV – Submerged Aquatic Vegetation
SEL – Sound Exposure Level
SL – Source Level
SPIF – Specific Project Information Form
SPR – Seattle Parks and Recreation, City of
SR – Southern Resident (Killer Whales)
TSS – Total Suspended Solids
USACE – U.S. Army Corps of Engineers
VSP – Viable Salmonid Population

WCR – West Coast Region (NMFS)
WDFW – Washington State Department of Fish and Wildlife
WDOE – Washington State Department of Ecology

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.

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.

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.

1.2 Consultation History

On June 11, 2021, the NMFS received a letter from the U.S. Army Corps of Engineers (USACE) that requested consultation for their authorization of Seattle Parks and Recreation's (SPR's) Leschi South Marina Wave Attenuator and Public Access Facility Improvements project on Lake Washington (USACE 2021a). The request included the City's Biological Evaluation (BE) and Specific Project Information Form (SPIF; SPR 2021a), Joint Aquatic Resource Permit Application (JARPA; SPR 2021b), and project drawings (Reid Middleton Inc. 2019).

On November 1, 2021, the NMFS informed USACE that we consider that the proposed action is likely to adversely affect PS Chinook salmon and their critical habitat, PS steelhead, and Pacific coast salmon EFH, and not likely to adversely affect southern resident killer whales and their critical habitat. We also requested additional information, including updated drawings. On February 28, 2022, the USACE requested formal consultation. On May 12, 2022, the NMFS requested SBR's mitigation plan for the project.

On June 8, 2023 the NMFS received 3 emails from SPR (SPR 2023a-c) with attached updated JARPA drawings (Reid Middleton Inc. 2023a), the project mitigation plan (SPR 2023d), and an underwater rubbish survey report (AUS 2023), as well as a link to the full set of 100% design drawings (Reid Middleton Inc. 2023b). The NMFS initiated formal ESA consultation and EFH consultation on June 8, 2023. On July 18, 2023, the NMFS received two emails from SPR, the first with an attachment to provide information requested by the NMFS (SPR 2023e - g).

This opinion is based on the information in the documents identified above, and other additional information provided by the applicant's agent; recovery plans, status reviews, and critical habitat designations for ESA-listed PS Chinook salmon and PS steelhead; published and unpublished scientific information on the biology and ecology of those species; and relevant scientific and gray literature (see Literature Cited).

1.3 Proposed Federal Action

Under the ESA, "action" means all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by Federal agencies (50 CFR 402.02). Under the 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 authorize the SPR (the applicant), under Section 10 of the Rivers & Harbors Act, to remove and replace an old mooring structure and an inadequate wave attenuator at the Leschi South Marina, which is located in Seattle, Washington, along the western shore of Lake Washington, about 0.7 miles north of the west end of the I-90 Bridge (Figure 1).

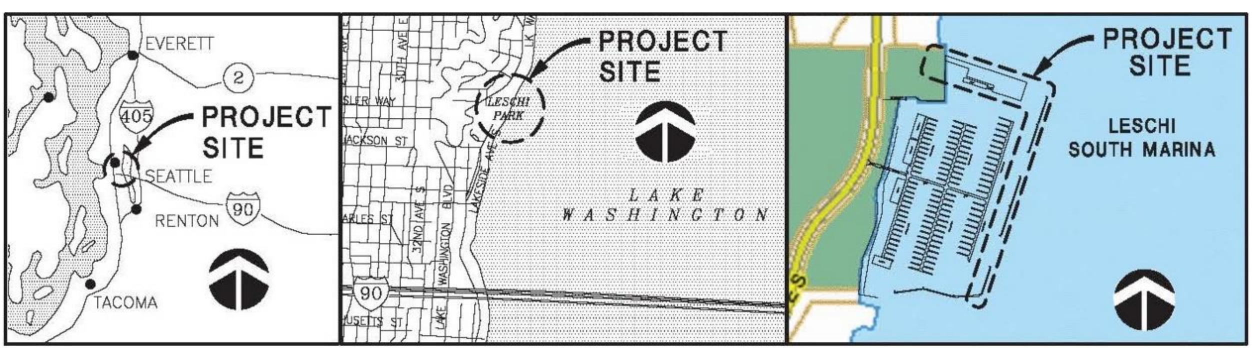

Figure 1. The project site on the west side of Lake Washington, in Seattle, Washington, east of Puget Sound, and north of the Interstate 90 Bridge. The marina components to be replaced are encircled by a dashed line in the map on the right (Adapted from Sheet 1 of 5 in Reid Middleton Inc. 2019).

Project Overview

The existing mooring structure that would be replaced is a solid-decked, 7,031-square foot, timber pier, ramp, and float at the north end of the marina (Figure 2). The pier, including its 61-foot long by 12-foot wide walkway, has an over-water area of 6,363 square feet. The underside of the walkway ranges from about 12 feet above the lake's ordinary high-water mark (OHWM) at it shore end, to 2 feet at the waterward end. The underside of the pier ranges between 12 and 24 inches above OHW. The entire structure is supported by 52 14-inch diameter creosote-treated timber piles. The ramp and float have an over-water area of about 688 s square feet. The float is currently used to moor a single patrol boat that is about 60 feet long. The structure is unlit at night. The existing 1,013-square foot wave attenuator consists of 6 floating steel pipes that are moored to 16 13-inch diameter galvanized steel piles, east of the marina (SPR 2023g).

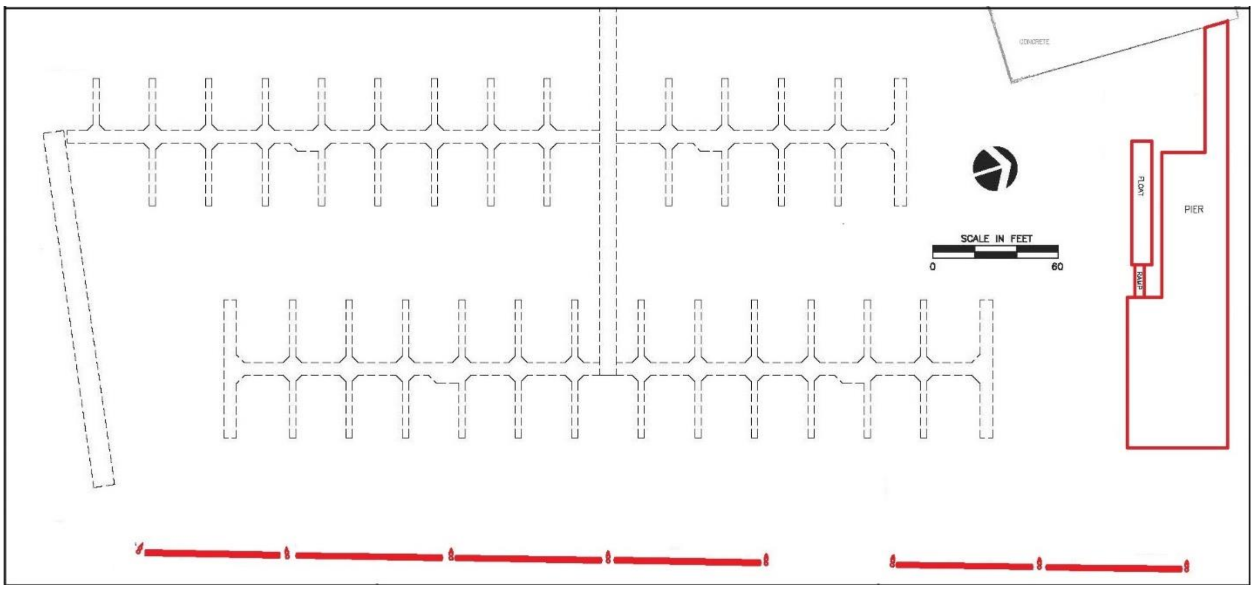

Figure 2. Overhead drawing of the existing configuration of the Leschi South Marina. The public access and mooring facility, and the wave attenuator that would be replaced are indicated in red (Adapted from Sheets 2 and 4 of 6 in Reid Middleton Inc. 2023a, and based on the current configuration of the inner mooring structures).

The replacement structures would consist of two interconnected over-water structures: 1) a public access and mooring facility (public access pier), and a combination wave attenuator mooring float (wave attenuator; Figure 3). The public access pier would connect the wave attenuator to the shore. It would consist of a 3,982-square foot pier, ramp, and float structure that would be fully decked with 60% open-space grated decking, and supported by 6 12-inch diameter and 6 24-inch diameter epoxy-coated steel pipe piles. Epoxy-coated steel would be used for structural framing, and aluminum would be used for gangways and railings. The undersides of its shoreside and transfer piers would be 12 and 5 feet above the OHWM, respectively, with the attached ramps sloping between their connection points. The shoreward end of the access pier's mooring float would be about 165 feet from shore, over water about 24 feet deep relative to the OHWM. The new mooring float would provide about 260 feet of temporary mooring space (i.e. availability for about 8 to 10 20- to 30-foot long vessels). Eighteen railing-mounted, low-intensity, louvered lights with frosted lenses, would be installed along both sides of the gangways and piers. Five light fixtures would be installed along the centerline of the float, 3 3.5-foot tall power pedestals with low-level bollard lighting, and 2 12-foot tall light poles with rectangular lenses that would direct the light along the float (SPR 2023g).

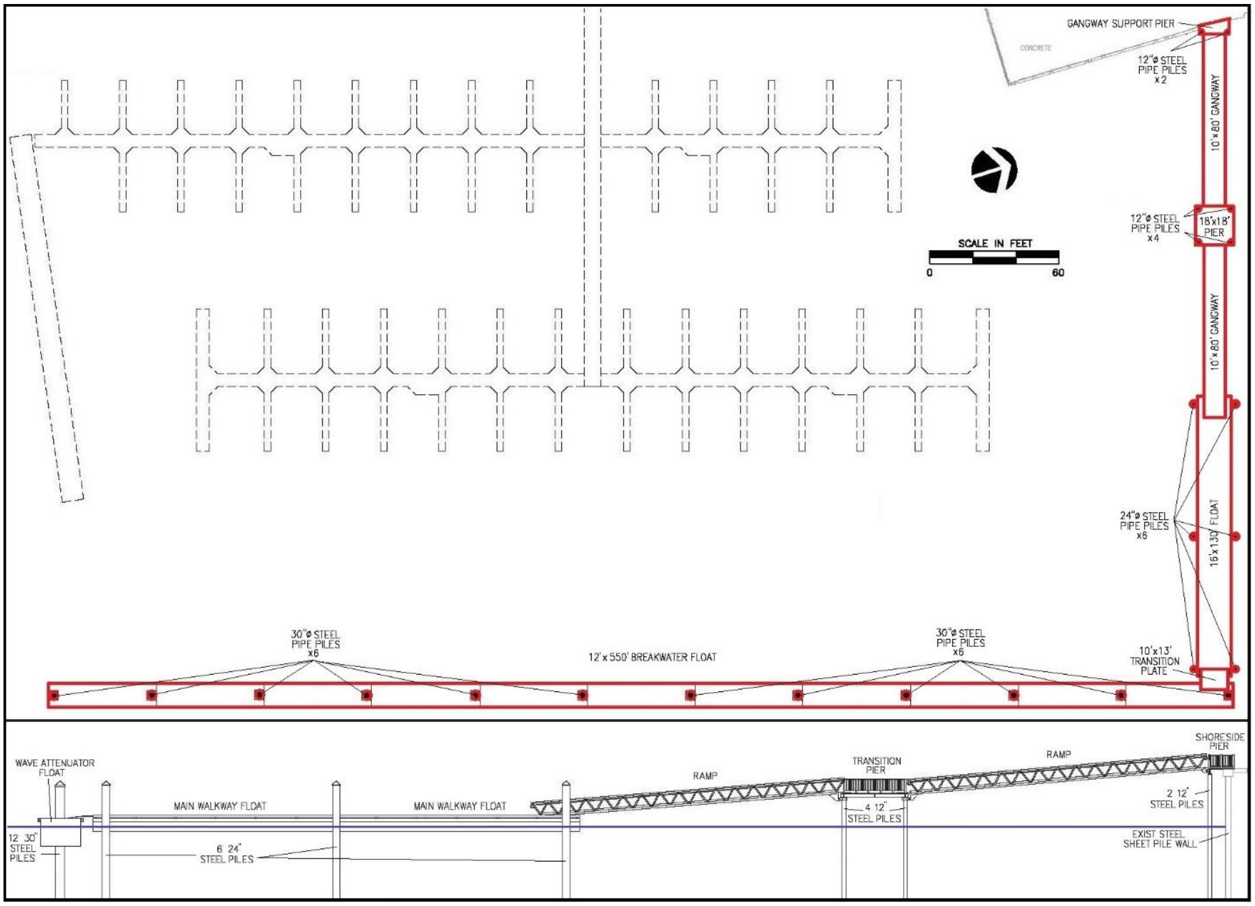

Figure 3. Overhead and profile drawings of the proposed configuration of the Leschi South Marina. The new public access and mooring facility and the wave attenuator mooring float are indicated in red in the upper image. The lower image shows the profile of the proposed public access and mooring facility as viewed from the north (Adapted from Sheets 4 and 6 of 6 in Reid Middleton Inc. 2023a).

The 550-foot long by 12-foot wide wave attenuator would be made of concrete, have an over-water area of 6,600 square feet, be solid-decked, and moored to 12 30-inch diameter epoxy-coated steel pipe piles. At its closest, it would be located about 320 feet from shore, over water at least 40 feet deep. It would provide about 1,084 feet of temporary mooring space (i.e. availability for about 30 to 50 20- to 30-foot long vessels). It would also include a sewer pump out facility. Eighteen light fixtures would be installed on the wave attenuator, 7 3.5-foot tall power pedestals with low-level bollard lighting, and 11 12-foot tall light poles with rectangular lenses that would be evenly spaced along the float's centerline. The lenses would orient the light parallel to the float's centerline (SPR 2023g).

To help offset the habitat impacts of the new structures, SPR also proposes remove accumulated debris from the lake bed that underlies the marina, an area of about 150,000 square feet (SPR

2023d). Based on the 2023 underwater survey of the marina, SPR would remove several tons of debris that include, but isn't limited to, 2 sunken vessels, a submerged building, sunken lumber and timber piles, sheet metal and other metallic debris, tires, bricks and concrete, roofing material, tarps and plastic sheets, bikes and an electric scooter, electronic components, and general rubbish (AUS 2023).

Demolition and Construction Details

The entire project, including upland work, would require up to 10 months to complete. After all permits have been obtained, in-water work would start and be completed within the first whole July 16 through April 30 in-water work window for the project area (SPR 2023f). All work would be done in compliance with the best management practices (BMPs) and conservation measures identified in the applicant's SPIF, JARPA Form, and the provisions identified in the Washington State Department of Fish and Wildlife (WDFW) Hydraulic Project Approval (HPA) for this project when issued. These measures include, but are not limited to, comprehensive lists of contractor requirements intended to reduce the risk of pollutants entering the lake, such as onsite Spill Prevention and Control Plan and maintenance of an onsite spill kit, pre-work installation of floating spill/debris booms and full-depth sediment curtains around pile extractions, and the use of vegetable oil-based lubricants and hydraulic fluids in heavy equipment.

Project work would be performed largely from a mix of construction, supply, and debris barges and small work boats, but would also include the use of standard land-based construction equipment and hand-held power tools, and the use of divers. Barges would hold position with spuds and or moor to existing structures. All debris from demolition, construction, and underwater debris removal would be temporarily placed on debris barges for transport to appropriately approved upland facilities for recycling and or disposal. For general debris, the barges would be equipped with containment and filtration systems to filter sediment-laden water before it would be allowed to return to the lake. For creosote-treated lumber and piles, the barges would be equipped with containment systems that would prevent water from returning to the lake. Creosote-contaminated waters would be discharged to approved upland facilities for treatment.

The project would begin with the removal of the existing structures. The construction crew would disconnect the utilities (water and electricity) running to the existing mooring structure, and disconnect/disassemble/demolish the existing float, ramp, and pier deck and framing. They would also disconnect the steel pipe wave attenuator from its mooring piles. Using a barge-mounted crane, the demolition debris would be placed on a debris barge.

They would then extract the 52 14-inch diameter creosote-treated timber pier piles and the 16 13-inch diameter galvanized steel wave attenuator piles using a barge-mounted crane. Full-depth sediment curtains would be installed to completely enclose all pile extraction work, and the curtains would be left in place until turbidity with them returns to the background level of the lake. Extraction would be done by direct-pull, or with a vibratory pile extractor if needed. If complete removal of a pile is not possible, divers would cut off the pile below the mud line. Extracted piles would be immediately placed on a debris barge equipped to contain sediments and fluids from the piles. The applicant anticipates that the loose unconsolidated sediments at the site would back-fill the pile holes, but commits to fill pile holes with clean sand if necessary.

The applicant anticipates that 8 to 10 piles would be removed per day, with about 10 minutes of vibratory extraction required per pile (SPR 2023g). At 8 piles per day, removal of all 68 piles would take 8.5 days. However, to account for possible work interruptions/delays, and to avoid underestimation of potential impacts, this opinion assumes that pile extraction could require up to 2 6-day workweeks to complete, with up to 100 minutes of vibratory work occurring on any of those days.

Following removal of the existing structures, the contractors would install the replacement structures that would be constructed off-site, and either barged or towed to the project site. The new floats would be towed into position, and 12 30-inch diameter steel pipe mooring piles would be installed through built-in pile hoops to secure them. The float pilings would be cut-off at a height of 5 feet above high-water level, and anti-bird-perching cones would be installed on their tops (SPR 2023g). The 6 12-inch diameter and 6 24-inch diameter steel pipe pier piles would be installed, and the construction crew would then use a barge-mounted crane to place and attach the new public access pier's pier tops, gangways, and transition plate. They would also reconnect the utilities to the new structures (power, water, sewer line for the new pump-out) will be installed from shore to the floats.

All pile installation would be done with a barge-mounted crane or derrick with a vibratory pile driver. No impact driving or proofing would be done. The applicant predicts that a maximum of 4 piles would be installed per day, with up to 60 minutes vibratory installation work required per pile (SPR 2023g). At 4 piles per day, installation of all 24 piles would take 6 days. However, to account for possible work interruptions/delays, and to avoid underestimation of potential impacts, this opinion assumes that pile installation could require up to 2 6-day workweeks to complete, with up to 240 minutes of vibratory work occurring on any of those days.

Underwater debris removal would be completed by divers and surface crews operating from barges and workboats, and is expected to require 2 weeks of in-water work to complete. Divers would locate debris that would likely be hoisted by some mix of lift-bags and crane-like equipment to place the debris onto a debris barge.

Other activities that could be caused by the proposed action

The NMFS also considered, under the ESA, whether or not the proposed action would cause any other activities that could affect our trust resources. We determined that the action would extend, by several decades, the useful life of the public access pier and the wave attenuator, with a combined total of about 1,344 linear feet of mooring space. The actual number of vessels that could moor on any given day would vary depending seasonality, and the sizes of the moored vessels. However, assuming a typical vessel length of about 24 feet, and no space between them, 56 vessels could moor to the new structures. Therefore, the action would facilitate the mooring and operation of about 50 vessels per day at and adjacent to the replacement structures for decades to come. Consequently, we have included an analysis of the effects of that vessel operation and moorage in the effects section 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 the NMFS, and section 7(b)(3) requires that, at the conclusion of consultation, the 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 the NMFS to provide an incidental take statement (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 that the proposed action is not likely to adversely affect PS Chinook salmon, PS steelhead, and designated critical habitat for PS Chinook salmon. They further determined that the proposed action would have no effect on any other species and critical habitats under NMFS jurisdiction. Because the NMFS has concluded that the proposed action is likely to adversely affect PS Chinook salmon, PS steelhead, and designated critical habitat for PS Chinook salmon, the NMFS has proceeded with formal consultation. Additionally, because of the trophic relationship between PS Chinook salmon and SR killer whales, the NMFS analyzed the action's potential effects on SR killer whales and their designated critical habitat in the "Not Likely to Adversely Affect" Determinations section 2.12 (Table 1).

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

ESA-listed species and or critical habitat likely to be adversely affected (LAA)				
Species	**Status**	**Species**	**Critical Habitat**	**Listed / CH Designated**
Chinook salmon (*Oncorhynchus tshawytscha*) Puget Sound	Threatened	LAA	LAA	06/28/05 (70 FR 37160) / 09/02/05 (70 FR 52630)
steelhead (*O. mykiss*) Puget Sound	Threatened	LAA	N/A	05/11/07 (72 FR 26722) / 02/24/16 (81 FR 9252)
ESA-listed species and critical habitat not likely to be adversely affected (NLAA)				
Species	**Status**	**Species**	**Critical Habitat**	**Listed / CH Designated**
killer whales (*Orcinus orca*) southern resident	Endangered	NLAA	NLAA	11/18/05 (70 FR 57565) / 11/29/06 (71 FR 69054)

LAA = likely to adversely affect NLAA = not likely to adversely affect
N/A = not applicable. The action area is outside designated critical habitat, or critical habitat has not been designated.

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 designation of critical habitat for PS Chinook salmon uses the terms primary constituent element or essential features. The 2016 final rule (81 FR 7414; February 11, 2016) that revised the critical habitat regulations (50 CFR 424.12) replaced those terms 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 primary constituent elements, essential features, or PBFs. In this biological opinion, we use the term PBF to mean primary constituent element 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.

Listed Species

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

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

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

"Abundance" generally refers to the number of naturally-produced adults that return to their natal spawning grounds.

"Productivity" refers to the number of naturally-spawning adults produced per parent. When progeny replace or exceed the number of parents, a population is stable or increasing. When progeny fail to replace the number of parents, the population is in decline.

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

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

Puget Sound (PS) Chinook Salmon

The PS Chinook salmon evolutionarily significant unit (ESU) was listed as threatened on June 28, 2005 (70 FR 37160). We adopted the recovery plan for this ESU in January 2007. The recovery plan consists of two documents: the Puget Sound salmon recovery plan (SSPS 2007) and the final supplement to the Shared Strategy's Puget Sound salmon recovery plan (NMFS 2006). The recovery plan adopts ESU and population level viability criteria recommended by the Puget Sound Technical Recovery Team (PSTRT) (Ruckelshaus et al. 2002). The PSTRT's biological recovery criteria will be met when all of the following conditions are achieved:

- The viability status of all populations in the ESU is improved from current conditions, and when considered in the aggregate, persistence of the ESU is assured;
- Two to four Chinook salmon populations in each of the five biogeographical regions of the ESU achieve viability, depending on the historical biological characteristics and acceptable risk levels for populations within each region;
- At least one population from each major genetic and life history group historically present within each of the five biogeographical regions is viable;
- Tributaries to Puget Sound not identified as primary freshwater habitat for any of the 22 identified populations are functioning in a manner that is sufficient to support an ESU-wide recovery scenario; Production of Chinook salmon from tributaries to Puget Sound not identified as primary freshwater habitat for any of the 22 identified populations occurs in a manner consistent with ESU recovery; and
- Populations that do not meet all the Viable Salmon Population (VSP) parameters are sustained to provide ecological functions and preserve options for ESU recovery.

General Life History: Chinook salmon are anadromous fish that require well-oxygenated water that is typically less than 63º F (17º C), but some tolerance to higher temperatures is documented with acclimation. Adult Chinook salmon spawn in freshwater streams, depositing fertilized eggs in gravel "nests" called redds. The eggs incubate for three to five months before juveniles hatch and emerge from the gravel. Juveniles spend from three months to two years in freshwater before migrating to the ocean to feed and mature. Chinook salmon spend from one to six years in the ocean before returning to their natal freshwater streams where they spawn and then die.

Chinook salmon are divided into two races, stream-types and ocean-types, based on the major juvenile development strategies. Stream-type Chinook salmon tend to rear in freshwater for a year or more before entering marine waters. Conversely, ocean-type juveniles tend to leave their natal streams early during their first year of life, and rear in estuarine waters as they transition into their marine life stage. Both stream- and ocean-type Chinook salmon are present, but ocean-type Chinook salmon predominate in Puget Sound populations. Chinook salmon are further grouped into "runs" that are based on the timing of adults that return to freshwater. Early- or spring-run chinook salmon tend to enter freshwater as immature fish, migrate far upriver, and finally spawn in the late summer and early autumn. Late- or fall-run Chinook salmon enter freshwater at an advanced stage of maturity, move rapidly to their spawning areas, and spawn within a few days or weeks. Summer-run fish show intermediate characteristics of spring and fall runs, without the extensive delay in maturation exhibited by spring-run Chinook salmon. In Puget Sound, spring-run Chinook salmon tend to enter their natal rivers as early as March, but do not spawn until mid-August through September. Returning summer- and fall-run fish tend to enter the rivers early-June through early-September, with spawning occurring between early August and late-October.

Yearling stream-type fish tend to leave their natal rivers late winter through spring, and move relatively directly to nearshore marine areas and pocket estuaries. Out-migrating ocean-type fry tend to migrate out of their natal streams beginning in early-March. Those fish rear in the tidal delta estuaries of their natal stream for about two weeks to two months before migrating to marine nearshore areas and pocket estuaries in late May to June. Out-migrating young of the year parr tend to move relatively directly into marine nearshore areas and pocket estuaries after leaving their natal streams between late spring and the end of summer.

Spatial Structure and Diversity: The PS Sound Chinook salmon ESU includes all naturally spawning populations of Chinook salmon from rivers and streams flowing into Puget Sound including the Straits of Juan De Fuca from the Elwha River, eastward, including rivers and streams flowing into Hood Canal, South Sound, North Sound and the Strait of Georgia in Washington. The ESU also includes the progeny of numerous artificial propagation programs (NWFSC 2015; Ford 2022). The PSTRT identified 22 extant populations, grouped into five major geographic regions, based on consideration of historical distribution, geographic isolation, dispersal rates, genetic data, life history information, population dynamics, and environmental and ecological diversity. The PSTRT distributed the 22 populations among five major biogeographical regions, or major population groups (MPGs), that are based on similarities in hydrographic, biogeographic, and geologic characteristics (Table 2).

Hatchery-origin spawners are present in high fractions in most populations within the ESU, with the Whidbey Basin the only MPG with consistently high fractions of natural-origin spawners. Between 1990 and 2019, the fraction of natural-origin spawners has declined in many of the populations outside of the Skagit watershed, and the ESU overall remains at a “moderate” risk of extinction (Ford 2022).

Abundance and Productivity: Available data on total abundance since 1980 indicate that abundance trends have fluctuated between positive and negative for individual populations, but productivity remains low in most populations, and hatchery-origin spawners are present in high fractions in most populations outside of the Skagit watershed. Further, across the ESU, 10 of 22 MPGs show natural productivity below replacement in nearly all years since the mid-1980s, and the available data indicate that there has been a general decline in natural-origin spawner abundance across all MPGs over the most-recent fifteen years. Further, escapement levels for all populations remain well below the PSTRT planning ranges for recovery (Ford 2022). Based on the current information on abundance, productivity, spatial structure and diversity, the most recent 5-year status review concluded that the PS Chinook salmon ESU remains at “moderate” risk of extinction, that viability is largely unchanged from the prior review, and that the ESU should remain listed as threatened (Ford 2022).

Limiting Factors: Factors limiting recovery for PS Chinook salmon include:

- Degraded floodplain and in-river channel structure

- Degraded estuarine conditions and loss of estuarine habitat
- Riparian area degradation and loss of in-river large woody debris
- Excessive fine-grained sediment in spawning gravel
- Degraded water quality and temperature
- Degraded nearshore conditions
- Impaired passage for migrating fish
- Severely altered flow regime

Table 2. Extant PS Chinook salmon populations in each biogeographic region (Ruckelshaus et al. 2002, NWFSC 2015).

Biogeographic Region	Population (Watershed)
Strait of Georgia	North Fork Nooksack River
	South Fork Nooksack River
Strait of Juan de Fuca	Elwha River
	Dungeness River
Hood Canal	Skokomish River
	Mid Hood Canal River
Whidbey Basin	Skykomish River
	Snoqualmie River
	North Fork Stillaguamish River
	South Fork Stillaguamish River
	Upper Skagit River
	Lower Skagit River
	Upper Sauk River
	Lower Sauk River
	Suiattle River
	Upper Cascade River
Central/South Puget Sound Basin	Cedar River
	North Lake Washington/ Sammamish River
	Green/Duwamish River
	Puyallup River
	White River
	Nisqually River

<u>PS Chinook Salmon within the Action Area:</u> The PS Chinook salmon most likely to occur in the action area would be fall-run Chinook salmon from the Cedar River and Sammamish River populations (Ford 2022; WDFW 2023a). Both stream- and ocean-type Chinook salmon are present in these populations, with the majority being ocean-types.

The Cedar River population is a relatively small native stock population with wild production (WDFW 2023b). Between 1980 and 2020, total abundance has fluctuated between about 600 and 1,600 spawners, with the average abundance trend (based on natural-origin spawning abundance) being slightly negative, and natural origin spawners fluctuating between about 50 and 80 percent (Ford 2022).

Sammamish River population is a small mixed stock population with composite production (WDFW 2023b). Between 1980 and 2020, total abundance has fluctuated between about 300 and 1,500 spawners, with the average abundance trend (based on natural-origin spawning abundance) being negative, and natural origin spawners fluctuating between about 10 and 50 percent (Ford 2022).

Adult and juvenile Chinook salmon primarily use the project site for freshwater migration, with juveniles also likely foraging while en route. Adult Chinook salmon pass through Chittenden Locks mid-June through September, with peak migration occurring in mid-August (City of Seattle 2008). Spawning occurs well upstream of the project area, between early August and late October. Juvenile Chinook salmon are found in Lake Washington between January and July, primarily in the littoral zone (Tabor et al. 2006). Juveniles emigrate through the ship canal and the locks between late-May and early-July, with the peak emigration in June (City of Seattle 2008).

<u>Puget Sound (PS) steelhead</u>

The PS steelhead distinct population segment (DPS) was listed as threatened on May 11, 2007 (72 FR 26722). In 2013, the Puget Sound Steelhead Technical Recovery Team (PSSTRT) identified 32 demographically independent populations (DIPs) within the DPS, based on genetic, environmental, and life history characteristics. Those DIPs are distributed among three geographically-based MPGs; Northern Cascades, Central and South Puget Sound; and Hood Canal and Strait de Fuca (Myers et al. 2015) (Table 3). Critical habitat for Puget Sound steelhead DPS was designated by NMFS in 2016 (81 FR 9251, February 24, 2016). NMFS adopted the steelhead recovery plan for the Puget Sound DPS in December, 2019.

In 2015, the PSSTRT concluded that the DPS is at "very low" viability; with most of the 32 DIPs and all three MPGs at "low" viability based on widespread diminished abundance, productivity, diversity, and spatial structure when compared with available historical evidence (Hard et al. 2015). Based on the PSSTRT viability criteria, the DPS would be considered viable when all three component MPG are considered viable. A given MPG would be considered viable when: 1) 40 percent or more of its component DIPs are viable; 2) mean DIP viability within the MPG exceeds the threshold for viability; and 3) 40 percent or more of the historic life history strategies (i.e., summer runs and winter runs) within the MPG are viable. For a given DIP to be considered viable, its probability of persistence must exceed 85 percent, as calculated by Hard et al. (2015), based on abundance, productivity, diversity, and spatial structure within the DIP.

<u>General Life History:</u> PS steelhead exhibit two major life history strategies. Ocean-maturing, or winter-run fish typically enter freshwater from November to April at an advanced stage of maturation, and then spawn from February through June. Stream-maturing, or summer-run fish typically enter freshwater from May to October at an early stage of maturation, migrate to headwater areas, and hold for several months prior to spawning in the following spring. After hatching, juveniles rear in freshwater from one to three years prior to migrating to marine habitats (two years is typical). Smoltification and seaward migration typically occurs from April to mid-May. Smolt lengths vary between watersheds, but typically range from 4.3 to 9.2 inches (109 to 235 mm) (Myers et al. 2015). Juvenile steelhead are generally independent of shallow

nearshore areas soon after entering marine water (Bax et al. 1978, Brennan et al. 2004, Schreiner et al. 1977), and are not commonly caught in beach seine surveys. Recent acoustic tagging studies (Moore et al. 2010) have shown that smolts migrate from rivers to the Strait of Juan de Fuca from one to three weeks. PS steelhead feed in the ocean waters for one to three years (two years is again typical), before returning to their natal streams to spawn. Unlike Chinook salmon, most female steelhead, and some males, return to marine waters following spawning (Myers et al. 2015).

Table 3. PS steelhead Major Population Groups (MPGs), Demographically Independent Populations (DIPs), and DIP Viability Estimates (Modified from Figure 58 in Hard *et al.* 2015).

Geographic Region (MPG)	Demographically Independent Population (DIP)	Viability
Northern Cascades	Drayton Harbor Tributaries Winter Run	Moderate
	Nooksack River Winter Run	Moderate
	South Fork Nooksack River Summer Run	Moderate
	Samish River/Bellingham Bay Tributaries Winter Run	Moderate
	Skagit River Summer Run and Winter Run	Moderate
	Nookachamps River Winter Run	Moderate
	Baker River Summer Run and Winter Run	Moderate
	Sauk River Summer Run and Winter Run	Moderate
	Stillaguamish River Winter Run	Low
	Deer Creek Summer Run	Moderate
	Canyon Creek Summer Run	Moderate
	Snohomish/Skykomish Rivers Winter Run	Moderate
	Pilchuck River Winter Run	Low
	North Fork Skykomish River Summer Run	Moderate
	Snoqualmie River Winter Run	Moderate
	Tolt River Summer Run	Moderate
Central and South Puget Sound	Cedar River Summer Run and Winter Run	Low
	North Lake Washington and Lake Sammamish Winter Run	Moderate
	Green River Winter Run	Low
	Puyallup River Winter Run	Low
	White River Winter Run	Low
	Nisqually River Winter Run	Low
	South Sound Tributaries Winter Run	Moderate
	East Kitsap Peninsula Tributaries Winter Run	Moderate
Hood Canal and Strait de Fuca	East Hood Canal Winter Run	Low
	South Hood Canal Tributaries Winter Run	Low
	Skokomish River Winter Run	Low
	West Hood Canal Tributaries Winter Run	Moderate
	Sequim/Discovery Bay Tributaries Winter Run	Low
	Dungeness River Summer Run and Winter Run	Moderate
	Strait of Juan de Fuca Tributaries Winter Run	Low
	Elwha River Summer Run and Winter Run	Low

Spatial Structure and Diversity: The PS steelhead DPS includes all naturally spawned anadromous steelhead populations in streams in the river basins of the Strait of Juan de Fuca, Puget Sound, and Hood Canal, Washington, bounded to the west by the Elwha River (inclusive) and to the north by the Nooksack River and Dakota Creek (inclusive). The DPS also includes six hatchery stocks that are considered no more than moderately diverged from their associated natural-origin counterparts (USDC 2014). PS steelhead are the anadromous form of *O. mykiss* that occur below natural barriers to migration in northwestern Washington State (Ford 2022). Non-anadromous ‘‘resident’’ *O. mykiss* (a.k.a. rainbow trout) occur within the range of PS steelhead but are not part of the DPS due to marked differences in physical, physiological, ecological, and behavioral characteristics (Hard et al. 2015). As stated above, the DPS consists of 32 DIPs that are distributed among three geographically-based MPG. An individual DIP may consist of winter-run only, summer-run only, or a combination of both life history types. Winter-run is the predominant life history type in the DPS (Hard et al. 2015).

Abundance and Productivity: Available data on total abundance since the late 1970s and early 1980s indicate that abundance trends have fluctuated between positive and negative for individual DIPs. The long-term abundance of adult steelhead returning to many rivers in Puget Sound has fallen substantially since estimates began for many populations in the late 1970s and early 1980s. Despite relative improvements in abundance and productivity for some DIPs between 2015 and 2019, particularly in the Central and South Puget Sound MPG, low productivity persists throughout the 32 DIPs, with most showing long term downward trends (Ford 2022). Since the mid-1980s, trends in natural spawning abundance have also been temporally variable for most DIPs but remain predominantly negative, well below replacement for most DIPs, and most DIPs remain small (Ford 2022). Over the time series examined, the over-all abundance trends, especially for natural spawners, remain predominantly negative or flat across the DPS, and general steelhead abundance across the DPS remains well below the level needed to sustain natural production into the future (Ford 2022). The PSSTRT concluded that the PS steelhead DPS is currently not viable (Hard et al. 2015). The most recent 5-year status review reported an increasing viability trend for the Puget Sound steelhead DPS, but also reported that the extinction risk remains moderate for the DPS, and that the DPS should remain listed as threatened (Ford 2022).

Limiting Factors: Factors limiting recovery for PS steelhead include:

- The continued destruction and modification of steelhead habitat
- Widespread declines in adult abundance (total run size), despite significant reductions in harvest in recent years
- Threats to diversity posed by use of two hatchery steelhead stocks (Chambers Creek and Skamania)
- Declining diversity in the DPS, including the uncertain but weak status of summer run fish
- A reduction in spatial structure
- Reduced habitat quality through changes in river hydrology, temperature profile, downstream gravel recruitment, and reduced movement of large woody debris
- In the lower reaches of many rivers and their tributaries in Puget Sound where urban development has occurred, increased flood frequency and peak flows during storms and reduced groundwater-driven summer flows, with resultant gravel scour, bank erosion, and sediment deposition
- Dikes, hardening of banks with riprap, and channelization, which have reduced river braiding and sinuosity, increasing the likelihood of gravel scour and dislocation of rearing juveniles

PS Steelhead within the Action Area: The PS steelhead most likely to occur in the action area would be winter-run steelhead from the Cedar River DIP, and the North Lake Washington and Lake Sammamish DIP (Ford 2022; WDFW 2023a). Both DIPs are among the smallest within the PS steelhead DPS.

The Cedar River PS steelhead DIP is extremely small, and is of an unknown stock with natural production. The total annual abundance has fluctuated between 0 and about 900 individuals between 1984 and 2021, with a strong negative trend, such that no more than 10 retuning adults are believed to have retuned annually since 2007. The estimated total number of returning adults in 2021 was only 4 fish (WDFW 2023c).

The North Lake Washington and Lake Sammamish DIP is extremely small, and of unknown stock origin. The total annual abundance has fluctuated between 0 and about 916 individuals between 1984 and 1999, with a steep negative trend until 1994, after which it flattened no more than 10 retuning adults. Abundance was only 4 adults during the last survey, which was done in 1999 (Ford 2022; WDFW 2023c).

Adult and juvenile steelhead salmon primarily use the project site for freshwater migration, with juveniles also likely foraging while en route. Returning adult steelhead typically pass through Chittenden Locks (aka Ballard Locks) and the Lake Washington Ship Canal between January and May, and may remain within Lake Washington through June (Seattle 2008). The timing of steelhead spawning across the basin is uncertain, but it occurs well upstream of the project area. Juvenile steelhead of these 2 DIPs typically leave their natal streams and enter Lake Washington in April. They emigrate through the ship canal and the through the locks between April and May (Seattle 2008).

Critical Habitat

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

The project site and surrounding area has been designated as critical habitat for PS Chinook salmon.

The NMFS designated critical habitat for PS Chinook salmon on September 2, 2005 (70 FR 52630). That critical habitat is located in 16 freshwater subbasins and watersheds between the Dungeness/Elwha Watershed and the Nooksack Subbasin, inclusively, as well as in nearshore marine waters of the Puget Sound that are south of the US-Canada border and east of the Elwha River, and out to a depth of 30 meters. Although offshore marine is an area type identified in the final rule, it was not designated as critical habitat for PS Chinook salmon.

The PBFs of salmonid critical habitat include: (1) Freshwater spawning sites with water quantity and quality conditions and substrate supporting spawning, incubation and larval development;

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

Major tributary river basins in the Puget Sound basin include the Nooksack, Samish, Skagit, Sauk, Stillaguamish, Snohomish, Lake Washington, Cedar, Sammamish, Green, Duwamish, Puyallup, White, Carbon, Nisqually, Deschutes, Skokomish, Duckabush, Dosewallips, Big Quilcene, Elwha, and Dungeness rivers and Soos Creek. Critical habitat throughout the Puget Sound basin has been degraded by numerous activities, including hydropower development, loss of mature riparian forests, increased sediment inputs, removal of large wood from the waterways, intense urbanization, agriculture, alteration of floodplain and stream morphology (i.e., channel modifications and diking), riparian vegetation disturbance, wetland draining and conversion, dredging, armoring of shorelines, marina and port development, road and railroad construction and maintenance, logging, and mining. Changes in habitat quantity, availability, and diversity, and flow, temperature, sediment load and channel instability are common limiting factors of critical habitat throughout the basin.

Land use practices have likely accelerated the frequency of landslides delivering sediment to streams. Fine sediment from unpaved roads also contributes to stream sedimentation. Unpaved roads are widespread on forested lands in the Puget Sound basin, and to a lesser extent, in rural residential areas. Historical logging removed most of the riparian trees near stream channels. Subsequent agricultural and urban conversion permanently altered riparian vegetation in the river valleys, leaving either no trees, or a thin band of trees. The riparian zones along many agricultural areas are now dominated by alder, invasive canary grass and blackberries, and provide substantially reduced stream shade and large wood recruitment (SSPS 2007).

Diking, agriculture, revetments, railroads and roads in lower stream reaches have caused significant loss of secondary channels in major valley floodplains in this region. Confined main channels create high-energy peak flows that remove smaller substrate particles and large wood. The loss of side-channels, oxbow lakes, and backwater habitats has resulted in a significant loss of juvenile salmonid rearing and refuge habitat. When the water level of Lake Washington was lowered 9 feet in the 1910s, thousands of acres of wetlands along the shoreline of Lake Washington, Lake Sammamish and the Sammamish River corridor were drained and converted to agricultural and urban uses. Wetlands play an important role in hydrologic processes, as they store water which ameliorates high and low flows. The interchange of surface and groundwater in complex stream and wetland systems helps to moderate stream temperatures. Thousands of acres of lowland wetlands across the region have been drained and converted to agricultural and urban uses, and forest wetlands are estimated to have diminished by one-third in Washington State (FEMAT 1993; Spence et al. 1996; SSPS 2007).

Table 4. Physical or biological features (PBFs) of designated critical habitat for PS Chinook salmon, with the corresponding life history events. Although offshore marine areas were identified in the final rule, none was designated as critical habitat.

Physical or Biological Features		
Site Type	**Site Attribute**	**Life History Event**
Freshwater spawning	Water quantity Water quality Substrate	Adult spawning Embryo incubation Alevin growth and development
Freshwater rearing	Water quantity and Floodplain connectivity Water quality and Forage Natural cover	Fry emergence from gravel Fry/parr/smolt growth and development
Freshwater migration	(Free of obstruction and excessive predation) Water quantity and quality Natural cover	Adult sexual maturation Adult upstream migration and holding Fry/parr/smolt growth, development, and seaward migration
Estuarine	(Free of obstruction and excessive predation) Water quality, quantity, and salinity Natural cover Forage	Adult sexual maturation and "reverse smoltification" Adult upstream migration and holding Fry/parr/smolt growth, development, and seaward migration
Nearshore marine	(Free of obstruction and excessive predation) Water quality, quantity, and forage Natural cover	Adult growth and sexual maturation Adult spawning migration Nearshore juvenile rearing
Offshore marine	Water quality and forage	Adult growth and sexual maturation Adult spawning migration Subadult rearing

Loss of riparian habitat, elevated water temperatures, elevated levels of nutrients, increased nitrogen and phosphorus, and higher levels of suspended sediment, presumably from urban and highway runoff, wastewater treatment, failing septic systems, and agriculture or livestock impacts, have been documented in many Puget Sound tributaries (SSPS 2007).

Peak stream flows have increased over time due to paving (roads and parking areas), reduced percolation through surface soils on residential and agricultural lands, simplified and extended drainage networks, loss of wetlands, and rain-on-snow events in higher elevation clear cuts

(SSPS 2007). In urbanized Puget Sound, there is a strong association between land use and land cover attributes and rates of coho spawner mortality likely due to runoff containing pollutants emitted from motor vehicles (Feist et al. 2011).

Dams constructed for hydropower generation, irrigation, or flood control have substantially affected PS Chinook salmon populations in a number of river systems. The construction and operation of dams have blocked access to spawning and rearing habitat, changed flow patterns, resulted in elevated temperatures and stranding of juvenile migrants, and degraded downstream spawning and rearing habitat by reducing recruitment of spawning gravel and large wood to downstream areas (SSPS 2007). These actions tend to promote downstream channel incision and simplification (Kondolf 1997), limiting fish habitat. Water withdrawals reduce available fish habitat and alter sediment transport. Hydropower projects often change flow rates, stranding and killing fish, and reducing aquatic invertebrate (food source) productivity (Hunter 1992).

Juvenile mortality occurs in unscreened or inadequately screened diversions. Water diversion ditches resemble side channels in which juvenile salmonids normally find refuge. When diversion headgates are shut, access back to the main channel is cut off and the channel goes dry. Mortality can also occur with inadequately screened diversions from impingement on the screen, or mutilation in pumps where gaps or oversized screen openings allow juveniles to get into the system. Blockages by dams, water diversions, and shifts in flow regime due to hydroelectric development and flood control projects are major habitat problems in many Puget Sound tributary basins (SSPS 2007).

The nearshore marine habitat has been extensively altered and armored by industrial and residential development near the mouths of many of Puget Sound’s tributaries. A railroad runs along large portions of the eastern shoreline of Puget Sound, eliminating natural cover along the shore and natural recruitment of beach sand (SSPS 2007). Degradation of the near-shore environment has occurred in the southeastern areas of Hood Canal in recent years, resulting in late summer marine oxygen depletion and significant fish kills. Circulation of marine waters is naturally limited, and partially driven by freshwater runoff, which is often low in the late summer. However, human development has increased nutrient loads from failing septic systems along the shoreline, and from use of nitrate and phosphate fertilizers on lawns and farms. Shoreline residential development is widespread and dense in many places. The combination of highways and dense residential development has degraded certain physical and chemical characteristics of the near-shore environment (HCCC 2005; SSPS 2007).

The PS Chinook salmon freshwater critical habitat at and adjacent to the project site primarily supports freshwater migration (NOAA 2023; WDFW 2023a).

2.3 Action Area

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

The project site is located in Seattle, Washington, along the western shore of Lake Washington, about 0.7 miles north of the west end of the I-90 Bridge (Figure 1). As described in section 2.5, work-related water quality effects would be the stressor with the greatest range of direct and indirect effects on fish. The affected area would be limited to the waters and substrates within about 300 feet around pile removal work and tugboat operations at the project site. Additionally, trophic connectivity between PS Chinook salmon and the SR killer whales that feed on them extends the action area to the marine waters of Puget Sound. The described area overlaps with the geographic ranges of the ESA-listed species and the boundaries of designated critical habitats identified in Table 1. The action area also overlaps with areas that have been designated, under the MSA, as EFH for Pacific Coast salmon, Pacific Coast groundfish, and coastal pelagic species.

2.4 Environmental Baseline

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

<u>Climate Change:</u> Climate change is a factor affecting the environmental baseline, aquatic habitats in general, and the status of the ESA-listed species considered in this opinion. Although its effects are unlikely to be spatially homogeneous across the region, 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. Major ecological realignments are already occurring in response to climate change (IPCC WGII 2022). Long-term trends in warming have continued at global, national, and regional scales. Global surface temperatures in the last decade (2010s) were estimated to be 1.09 °C higher than the 1850-1900 baseline period, with larger increases over land ~1.6 °C compared to oceans ~0.88 °C (IPCC WGI 2021). The vast majority of this warming has been attributed to anthropogenic releases of greenhouse gases (IPCC WGI 2021). Globally, 2014 through 2018 were the 5 warmest years on record both on land and in the ocean (NOAA NCEI 2022). Events such as the 2013 through 2016 marine heatwave (Jacox et al. 2018) have been attributed directly to anthropogenic warming. Global warming and anthropogenic loss of biodiversity represent profound threats to ecosystem functionality (IPCC WGII 2022). These two factors 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 for in the recent literature (Siegel and Crozier 2020).

Climate change is systemic, influencing freshwater, estuarine, and marine conditions. Other systems are also being influenced by changing climatic conditions. Literature reviews on the impacts of climate change on Pacific salmon (Crozier 2015; 2016; 2017; Crozier and Siegel 2018; Siegel and Crozier 2019; 2020) have collected hundreds of papers documenting the major themes relevant for salmon. Below, 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 continue to impact forests of the western U.S., which dominate the landscape of many watersheds in the region. Forests are already showing evidence of increased drought severity, forest fire, and insect 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:

The magnitude of low river flows in the western U.S., which generally occur in September or October, and are driven largely by summer conditions and the prior winter's precipitation.

Although, low flows are more sensitive to summer evaporative demand than to winter precipitation, interannual variability is greater for winter precipitation. Malek et al. (2018), predicted that summer evapotranspiration is likely to increase in conjunction with declines in snowpack and increased variability in winter precipitation, which suggests that summer flows are likely to become lower, more variable, and less predictable over time.

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

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

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

Marine and Estuarine Environments

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

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

Perhaps the most dramatic change in physical ocean conditions will occur through ocean acidification and deoxygenation. It is unclear how sensitive salmon and steelhead might be to the direct effects of ocean acidification because of their tolerance of a wide pH range in freshwater (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, Ward et al. 2015; Williams et al. 2016). 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).

<u>Climate change effects on salmon and steelhead</u>

In freshwater, year-round increases in stream temperature and changes in flow will affect physiological, behavioral, and demographic processes in salmon, and change the species with which they interact. For example, as stream temperatures increase, many native salmonids face increased competition with more warm-water tolerant invasive species. Changing freshwater temperatures are likely to affect incubation and emergence timing for eggs, and in locations where the greatest warming occurs may affect egg survival, although several factors impact inter-gravel temperature and oxygen (e.g., groundwater influence) as well as sensitivity of eggs to thermal stress. 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 (FitzGerald et al. 2020). Rising river temperatures increase the energetic cost of migration and the risk of in-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 (Barnett et al. 2020; Keefer et al. 2018).

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 (Burke et al. 2013; Holsman et al. 2012). It is generally accepted that salmon marine survival is size-dependent, and thus larger and faster growing fish are more likely to survive (Gosselin et al. 2021). Furthermore, early arrival timing in the marine environment is generally considered advantageous for populations migrating through the Columbia River. However, the optimal day of arrival varies across years, depending on the seasonal development of productivity in the California Current, which affects prey available to salmon and the risk of predation (Chasco et al. 2021). Siegel and Crozier (2019) point out the concern that for some salmon populations, climate change may drive mismatches between juvenile arrival timing and prey availability in the marine environment. However, phenological diversity can contribute to metapopulation-level resilience by reducing the risk of a complete mismatch. Carr-Harris et al. (2018), explored phenological diversity of marine migration timing in relation to zooplankton prey for sockeye salmon O. nerka from the Skeena River of Canada. They found that sockeye migrated over 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 (Stachura el al. 2014) and Atlantic salmon (Olmos et al. 2020) also have demonstrated synchrony in productivity across a broad latitudinal range.

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

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

<u>Environmental conditions at the project site and the surrounding area:</u> The project site is located in Seattle, Washington, along the western shore of Lake Washington, about 0.7 miles north of the west end of the I-90 Bridge (Figure 1). Although the action area includes the marine waters of Puget Sound, all detectable effects of the action would be limited to Lake Washington within about 300 feet around the project site (Section 2.5). Therefore, this discussion focuses on habitat conditions in Lake Washington, and does not discuss Puget Sound habitat conditions.

Lake Washington is a long, narrow, freshwater lake with steeply sloping sides. It is about 22 miles long, north to south, has an average width of 1.5 miles, and covers about 21,500 acres. The lake has an average depth of about 100 feet, and is just over 200 feet deep at its deepest (City of Seattle 2010). The Lake Washington watershed covers about 300,000 acres (472 square miles), and its major influent streams are the Cedar and Sammamish Rivers. The Cedar River enters at the southern end of the lake and contributes about 57 percent of the lake's water. The Sammamish River enters at the north end of the lake, and contributes about 27 percent of the lake's water (King County 2016).

Numerous creeks, including Coal, Forbes, Juanita, May, McAleer, Ravenna, and Thornton Creeks also flow directly into Lake Washington.

The geography and ecosystems in and adjacent to the action area have been dramatically altered by human activity since European settlers first arrived in the 1800s. Historically, the Cedar River did not enter the lake, and Lake Washington's waters flowed south to the Duwamish River via the now absent Black River. In the 1880s, dredging and excavation was started to create a navigable passage between Lake Washington and the marine waters of Shilshole Bay. In 1911, engineers rerouted the Cedar River into Lake Washington to create an industrial waterway and to prevent flooding in Renton. In 1916, the Lake Washington Ship Canal was opened, which lowered water levels in the lake by about nine feet, and stopped flows through the Black River.

The majority of the lake's watershed is now highly developed and urban in nature with 63 percent of the area considered fully developed (King County 2016). The City of Seattle boarders most of the west side of the lake. The cities of Bellevue and Kirkland are along the eastern shoreline, with the Cities of Kenmore and Renton on the north and south ends, respectively.

Water quality in the lake has been impacted by point and nonpoint pollution sources including past sewage discharges. Ongoing sources include stormwater discharges and subsurface runoff containing pollutants from roadways, failing septic systems, underground petroleum storage tanks, and fertilizers and pesticides from commercial and residential sites. It has also been impacted by upstream forestry and agricultural practices. Cleanup efforts since the 1960s and 1970s, including diversion of wastewater away from the lake, have improved conditions, such that water quality in the lake is generally considered good (City of Seattle 2010).

Urban development has converted most of the original lake shoreline from a mix of thick riparian forests, shrub-scrub, and emergent wetlands to residential gardens and lawns, with only small scattered patches of natural riparian growth remaining (Toft 2001). Additionally, as of the year 2000, over 70 percent of the lake's shoreline had been armored by bulkheads and rip rap, and over 2,700 docks had been installed around the lake (Toft 2001). It is almost certain that those numbers have increased since then.

The armored shorelines around most of Lake Washington, have converted the gently sloping gravel shorelines with very shallow waters that are favored by juvenile salmon, into artificially steep substrates with relatively deep water. Numerous piers and docks create harsh over-water shadows that limit aquatic productivity and hinder shoreline migration of juvenile salmon. Additionally, the artificial shorelines and overwater structures provide habitat conditions that favor fish species that prey on juvenile salmonids, especially the non-native smallmouth bass. Other predators in the lake include the native northern pikeminnow and the non-native largemouth bass (Celedonia et al. 2008a; 2008b; Tabor et al. 2010).

The Leschi South Marina site was first developed in 1889 as a landing site to provide cable car access across the Lake, then later to support a ferry. A marina was established at the site in 1905. The current marina was built in 1949, and improved in the 1970s. The shoreline area consists primarily of a steeply sloped low bank and small rock armoring along the OHWM. Above the OHWM is a wide swath of grass with clusters of trees and shrubs, a pedestrian trail, and park benches. The north end of the shoreline consists of a concrete bulkhead supporting a parking area and a dock. Water depths range from about 0 to 2 feet along the shoreline, sloping moderately to about 51 feet under the eastern wave attenuator (Sheet 3 of 5 in Reid Middleton Inc. 2019).

An underwater rubbish survey completed February 2023 observed large areas of sunken debris under the marina. Reported debris included 2 sunken vessels, a submerged building, sunken lumber and timber piles, sheet metal and other metallic debris, tires, bricks and concrete, roofing material, tarps and plastic sheets, bikes and an electric scooter, electronic components, and general rubbish (AUS 2023). Low densities of an invasive waterlily have also been documented at the site.

The water at the marina and the surrounding area is categorized by the State's Department of Ecology (WDOE) as a Category I waterbody for bacteria (WDOE 2023). WDOE indicates no sediment contamination at the site. However, the long-term presence of creosote-treated timber piles at the site suggests that some level of contamination by Polycyclic Aromatic Hydrocarbons (PAHs) likely exists in the water and sediments. Additionally, the marina's artificial shoreline and overwater structures likely induce migratory delays for juvenile salmonids, and provide habitat conditions that favor piscivorous fish such northern pikeminnow, smallmouth bass, and largemouth bass that prey on juvenile salmonids.

The past and ongoing anthropogenic impacts described above have impacted these species and the attributes of critical habitat at the project site and surrounding areas. However, adult and juvenile PS Chinook salmon and PS steelhead continue to migrate through the project area annually.

2.5 Effects of the Action

Under the ESA, "effects of the action" are all consequences to listed species or critical habitat that are caused by the proposed action, including the consequences of other activities that are caused by the proposed action (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).

As described in Section 1.3, the USACE would authorize SPR to perform up to 10 months of in- and over-water work at the Leschi South Marina. Work would likely begin during the first July 16 through April 30 in-water work window after receiving all required authorizations, and is expected to require a single work season to complete. The project would replace a 7,031-square foot pier, ramp, and float mooring structure and a 1,013-square foot floating-pipe wave attenuator (Figure 2) with two interconnected structures with a combined over-water area of 10,582 square feet (Figure 3). Work would primarily be done from construction barges, and would include the demolition and removal of the existing structures and their supporting piles, the vibratory installation of new epoxy-coated/galvanized steel piles and the piers, ramps, and floats of the new structures. The project would also include the use of divers and support craft to remove sunken debris from the lake bed across the entire area of the marina.

The best available information about the proposed work supports the understanding that the demolition and construction would cause direct effects on fish and habitat resources at the project site through exposure to work-related noise, pollutants, and propeller wash. The proposed work would also cause indirect effects on fish and habitat resources through work-related forage diminishment. The USACE's authorization of the project would also have the additional effect of extending the operational life of the affected structures by several decades beyond their existing conditions. Over that time, those structures' presence and normal operations would cause effects on fish and habitat resources through structure-related altered lighting, pollutants, elevated noise, propeller wash, and forage diminishment.

The action's in-water work window overlaps with the normal migration season for returning adult PS Chinook salmon and the pre-peak part of emigration season for juveniles. The work window also overlaps with the normal migration seasons for juvenile and adult PS steelhead. However, PS steelhead are very rare in the Lake Washington watershed, which supports the expectation that it is very unlikely that any PS steelhead would be within the affected area during the proposed in-water work.

Over the decades-long existence of the new structures, adults and juveniles of both species are likely to pass through the project area during their respective annual migration seasons, where they may be exposed to the action's indirect effects. The PBFs of PS Chinook salmon critical habitat would also be exposed to the action's direct and indirect effects.

2.5.1 Effects on Listed Species

Effects on species are a function of exposure and response. The duration, intensity, and frequency of exposure, and the life stage at exposure all influence the degree of response.

As described above, the proposed action would cause a mix of direct and indirect effects, several of which would have common stressors, such as work- and structure-related noise, pollutants, and propeller wash. To reduce redundant discussions, the following analysis groups the common work- and structure-related stressors of noise, pollutants, and propeller wash into 3 discussions, followed by structure-related altered lighting. Because many of the stressors are also likely to impact salmonid forage resources, work- and structure-related forage diminishment will be analyzed together after the other stressors have been analyzed.

Work- and Structure-related Noise

Exposure to work-related noise is likely to adversely affect juvenile PS Chinook salmon, but cause only minor effects for adult Chinook salmon. Steelhead smolts and or adults are extremely unlikely to be exposed. Exposure to structure-related noise is likely to adversely affect juvenile PS Chinook salmon and juvenile PS steelhead, but cause only minor effects for adults of both species.

The proposed in-water work, and post-construction structure-related vessel operations would cause fish-detectable levels of in-water noise. The effects caused by a fish's exposure to noise vary with the hearing characteristics of the fish, the frequency, intensity, and duration of the exposure, and the context under which the exposure occurs. At low levels, effects may include the onset of behavioral disturbances such as acoustic masking (Codarin et al. 2009), startle responses and altered swimming (Neo et al. 2014), abandonment or avoidance of the area of acoustic effect (Mueller 1980; Picciulin et al. 2010; Sebastianutto et al. 2011; Xie et al. 2008), and increased vulnerability to predators (Simpson et al. 2016). At higher intensities and or longer exposure durations, the effects may rise to include temporary hearing damage (a.k.a. temporary threshold shift (TTS), Scholik and Yan 2002) and increased stress (Graham and Cooke 2008). At even higher levels, exposure may lead to physical injury that can range from the onset of permanent hearing damage (a.k.a. permanent threshold shift (PTS)) and mortality. The best available information about the auditory capabilities of the fish considered in this opinion suggest that their hearing capabilities are limited to frequencies below 1,500 Hz, with peak sensitivity between about 200 and 300 Hz (Hastings and Popper 2005; Picciulin et al. 2010; Scholik and Yan 2002; Xie et al. 2008).

The NMFS uses two metrics to estimate the onset of injury for fish exposed to high intensity impulsive sounds (Stadler and Woodbury 2009). The metrics are based on exposure to peak sound level and sound exposure level (SEL). Both are expressed in decibels (dB). The metrics are: 1) exposure to 206 dB_{peak}; and 2) exposure to 187 dB SEL_{cum} for fish 2 grams or larger, or 183 dB SEL_{cum} for fish under 2 grams. Further, any received level (RL) below 150 dB_{SEL} is considered “Effective Quiet”. The distance from a source where the RL drops to 150 dB_{SEL} is considered the maximum distance from that source where fishes can potentially experience TTS or PTS from the noise, regardless of accumulation of the sound energy (Stadler and Woodbury 2009). When the range to the 150 dB_{SEL} isopleth exceeds the range to the applicable SEL_{CUM} isopleth, the distance to the 150 dB_{SEL} isopleth is typically considered the range at which detectable behavioral effects would begin, with the applicable SEL_{CUM} isopleth identifying the distance within which sound energy accumulation would intensify effects. However, when the range to the 150 dB_{SEL} isopleth is less than the range to the applicable SEL_{CUM} isopleth, only the 150 dB_{SEL} isopleth would apply because no accumulation of effects are expected for noise levels below 150 dB_{SEL}. This assessment considers the range to the 150 dB_{SEL} isopleths as the maximum ranges for detectable acoustic effects from exposure to work-related noise.

The discussion in Stadler and Woodbury (2009) indicate that these thresholds likely overestimate the potential effects of exposure to impulsive sounds. Further, Stadler and Woodbury’s assessment did not consider non-impulsive sound, which is believed to be less injurious to fish than impulsive sound. Therefore, application of the criteria to non-impulsive sounds is also likely to overestimate the potential effects in fish. However, these criteria represent the best available information. Therefore, to avoid underestimating potential effects, this assessment applies these criteria to the impulsive and non-impulsive sounds that are expected from the proposed work to gain a conservative idea of the potential effects that fish may experience due to exposure to that noise.

Elevated in-water noise at levels capable of causing detectable effects in exposed fish would be caused by up to 10 months of project-related work, and decades of vessel operation at the replacement pier and wave attenuator. The proposed project would include a mix of in-and above-water work that would include the use of vibratory pile extraction/installation equipment, tugboats and small workboats, and various hand-held power tools. Of these, the pile extraction/installation would be the loudest sources, followed by tugboats and power tool use. The replacement structures are expected to support the moorage of up to about 50 vessels ranging in size from about 12 to over 50 feet in length, most are expected to be powerboats close to 24 feet in length.

This assessment includes the above-water use of power tools in addition to in-water sound sources because some sound from the above-water work is likely to radiate into the water. That sound transfer would be highest in situations where the power tool is in direct contact with structures such as piles, floats, and the decks of barges and workboats that are in direct contact with the water. To avoid underestimating potential impacts, this assessment assumes that above-water power tool noise would enter the water as if originated in the water, and that it could be present around the affected structures and vessels anytime during the 10 months of project work.

The estimated source levels (SL, sound level at 1 meter from the source) and acoustic signature information used in this assessment for in-water work are based on the best available information, as described in multiple acoustic assessments for similar projects (NMFS 2017; 2018), and in other sources (Blackwell and Greene 2006; CalTrans 2015; 2020; FHWA 2017; McKenna et al. 2012; Picciulin et al. 2010; Richardson et al. 1995).

In the absence of location-specific transmission loss data, the NMFS typically uses some variation of the equation RL = SL – #Log(R) to estimate the received sound level at a given range from a source (RL = received level (dB); SL = source level (dB, 1 m from the source); # = spreading loss coefficient; and R = range in meters (m). Numerous acoustic measurements in shallow water environments support the use of a spreading loss coefficient of about 15 for projects like this one (CalTrans 2015). This value is considered the practical spreading loss coefficient, and was used for all sound attenuation calculations in this assessment.

The best available information indicates that instantaneously injurious noise levels at or above the 206 dB_{peak} threshold could exist within 1 meter around the new wave attenuator's 30-inch steel pipe piles during their vibratory installation, but that the SLs for all other in-water work would be below that threshold. Application of the practical spreading loss equation to the expected in-water SLs for project-related work suggests that sound levels at or above the 150 dB_{SEL} threshold could extend to about 177 feet (54 m) around spud deployments, 95 feet (29 m) around vibratory installation of 30-inch steel pipe piles, 72 feet (22 m) around tugboat operations and vibratory extraction of 14-inch timber piles, 33 feet (10 m) during power tool use and 23-foot powerboat operations, and 16 feet (5 m) or less around all other sources (Table 5).

<u>Work-related Noise Effects:</u> The exact timing of the various work components and how they might overlap with the presence of Chinook salmon is uncertain. Consequently, to avoid underestimating impacts, this assessment assumes that both juvenile and adult Chinook salmon could be exposed to any of the work-related noise sources. If adult Chinook salmon are present near the project site during any portion of the proposed work, it is extremely unlikely that any individuals would approach close enough or remain within the project's ensonified areas long enough to experience any fitness impacts. Given their independence of shoreline habitats, individuals would, at most, detect the noise, and avoid the ensonified area. Because the areal avoidance wouldn't interfere with their migration to or from their natal streams or prevent access

to any other important habitat resources, the exposure would cause no meaningful impacts on their fitness or normal behaviors. Conversely, the juvenile Chinook salmon that annually pass through the lake are strongly shoreline-obligated. Therefore, individuals that migrate along the east side of the lake from south of the project site must pass through the project area to reach Puget Sound via the ship canal.

Table 5. Estimated in-water source levels for the loudest expected project-related work with source-specific estimated ranges to the applicable effect thresholds for fish.

Source	Acoustic Signature	Source Level	Threshold Range
Vib. Install 30-inch Steel Pipe piles	< 2.5 kHz Non-Impulsive	206 dB$_{peak}$	206 dB$_{peak}$ @ 1 m
4 days of 180 minutes of work per day.		172 dB$_{SEL}$	187 SEL$_{CUM}$ @ N/A
		172 dB$_{SEL}$	150 dB$_{SEL}$ @ 29 m
Steel Spud Deployment	< 1,600 Hz Impulsive	201 dB$_{peak}$	206 dB$_{peak}$ @ N/A
Sporadic episodes of 2 to 4 impulses anytime a barge is positioned.		176 dB$_{SEL}$	187 SEL$_{CUM}$ @ N/A
		176 dB$_{SEL}$	150 @ 54 m
Vib. Install 24-inch Steel Pipe piles	< 2.5 kHz Non-Impulsive	193 dB$_{peak}$	206 dB$_{peak}$ @ N/A
2 days of 180 minutes of work per day.		159 dB$_{SEL}$	187 SEL$_{CUM}$ @ N/A
		159 dB$_{SEL}$	150 @ 4 m
85-foot Tourist Ferry	< 2 kHz Combination	187 dB$_{peak}$	206 dB$_{peak}$ @ N/A
Episodic periods measured in minutes to hours.		177 dB$_{SEL}$	187 SEL$_{CUM}$ @ N/A
		177 dB$_{SEL}$	150 @ 63 m
Tugboat Operation	< 2 kHz Combination	185 dB$_{peak}$	206 dB$_{peak}$ @ N/A
Episodic periods measured in minutes to hours.		170 dB$_{SEL}$	187 SEL$_{CUM}$ @ N/A
		170 dB$_{SEL}$	150 dB$_{SEL}$ @ 22 m
Pneumatic Tools (i.e. impact wrench)	Est. < 2 kHz Impulsive	185 dB$_{peak}$	206 dB$_{peak}$ @ N/A
Assumed 8 hours per day over 10 months of work.		165 dB$_{SEL}$	187 SEL$_{CUM}$ @ 32m
		165 dB$_{SEL}$	150 dB$_{SEL}$ @ 10 m
Pumps	Est. < 2 kHz Impulsive	181 dB$_{peak}$	206 dB$_{peak}$ @ N/A
Assumed 8 hours per day over 10 months of work.		161 dB$_{SEL}$	187 SEL$_{CUM}$ @ 17m
		161 dB$_{SEL}$	150 dB$_{SEL}$ @ 5 m
Vib. Extract 14-inch Timber piles	< 2.5 kHz Non-Impulsive	180 dB$_{peak}$	206 @ N/A
7 days of 80 minutes of work per day.		170 dB$_{SEL}$	187 SEL$_{CUM}$ @ N/A
		170 dB$_{SEL}$	150 @ 22 m
Air Compressor	Est. < 2 kHz Impulsive	178 dB$_{peak}$	206 dB$_{peak}$ @ N/A
Assumed 8 hours per day over 10 months of work.		158 dB$_{SEL}$	187 SEL$_{CUM}$ @ 11m
		158 dB$_{SEL}$	150 dB$_{SEL}$ @ 3 m
23-foot Boat w/ 2 4~ 100 HP Engines.	< 2 kHz Combination	175 dB$_{peak}$	206 dB$_{peak}$ @ N/A
Episodic periods measured in minutes to hours.		165 dB$_{SEL}$	187 SEL$_{CUM}$ @ N/A
		165 dB$_{SEL}$	150 @ 10 m
Vib. Extract 13-inch Steel Pipe piles	< 2.5 kHz Non-Impulsive	171 dB$_{peak}$	206 @ N/A
3 days of 80 minutes of work per day.		155 dB$_{SEL}$	187 SEL$_{CUM}$ @ N/A
		155 dB$_{SEL}$	150 dB$_{SEL}$ @ 2 m
Vib. Install 12-inch Steel Pipe piles	< 2.5 kHz Non-Impulsive	171 dB$_{peak}$	206 @ N/A
2 days of 180 minutes of work per day.		155 dB$_{SEL}$	187 SEL$_{CUM}$ @ N/A
		155 dB$_{SEL}$	150 dB$_{SEL}$ @ 2 m

Because the existing and proposed wave attenuators are and would be more than 320 feet away from the closest shoreline at the site, it is extremely unlikely that any juvenile Chinook salmon would approach close enough to be exposed to injurious noise levels from the vibratory installation of 30-inch steel pipe piles. However, juvenile Chinook salmon are very likely to be exposed to the sounds from virtually any of the other work-related noise sources. Many of those sound sources could overlap temporally during the completion of this project. However, the sound sources are very unlikely to have any additive effects on sound intensity due the differences in the frequencies and other characteristics of their sounds. At most, the combination of the various types of equipment noise during any given day would cause fish-detectable in-water noise levels across the entire workday.

Therefore, to be protective of fish, this assessment assumes that for 10 months, during any work day, work-related in-water noise levels above 150 dB_{SEL} would be continuously present somewhere within 33 feet (10 m) of the affected structures and work barges. Further, during tugboat operations and the 7 days of 14-inch pile extraction, noise levels above 150 dB_{SEL} would be episodically present within 72 feet (22 m) around those activities. Also, during spud deployment, which would likely occur infrequently (no more than every few days or so when a barge is positioned), and consist of 2 to 4 very brief (< 0.5-second) impulses, impulsive noise above 150 dB_{SEL} would be present up to about 177 feet (54 m) around the spud barge. However, the number of daily impulsive events would be too low to cause any fitness impacts due to the accumulation of sound energy.

Juvenile Chinook salmon that enter within any of the various work-related 150 dB_{SEL} isopleths are likely to experience behavioral disturbances, such as acoustic masking, startle responses, altered swimming patterns, areal avoidance and or delayed migration past the project area, and increased risk of predation. The intensity of these effects would likely increase with increased proximity to the source. Response to this exposure would be non-lethal in most cases. However, as is explained in more detail in the assessment of structure-related altered lighting, migratory impacts can reduce the long-term survival of juvenile salmonids, and individuals that are eaten by predators would obviously be killed.

<u>Structure-related Noise Effects:</u> Because structure-related vessel operations could occur at any time of the year, and over several decades after construction, this assessment assumes that juvenile and adult Chinook salmon and steelhead could be exposed to the noise from structure-related vessel operations. For the same reasons expressed above under work-related noise effects, it is it is extremely unlikely that adult Chinook salmon or steelhead would experience anything more than minor behavioral responses that would cause no meaningful impacts on their fitness or normal behaviors. However, shoreline-obligated juvenile Chinook salmon that migrate along the east side of the lake from south of the project site would be compelled to pass through the project area. Also, over the decades-long lives of replacement structures, low numbers of steelhead smolt may pass through the project area.

It is extremely unlikely that vessels would be run at anything close to full speed while near the replacement structures, and all vessel-related noise levels would be non-injurious. However, vessels may briefly use high power settings while maneuvering. To be protective of fish, this assessment assumes that vessels up to the size and power levels of a tugboat would be routinely operated at the replacement structures, and that related noise levels above the 150 dB_{SEL} threshold could routinely extend 72 feet (22 m) around those structures. As stated above, the response of juvenile Chinook salmon and steelhead that are within the 150 dB_{SEL} isopleths of vessel operation would be non-lethal in most cases, but could result in reduced long-term survival for some individuals, and any individuals that are eaten by predators would be killed.

In summary, work- and or structure-related noise would cause some combination of altered behaviors and or increased risk of predation that could reduce fitness or cause mortality for some of the juvenile PS Chinook salmon and juvenile PS steelhead that pass the site. The annual numbers of those listed fish that may be exposed to this stressor are unquantifiable with any degree of certainty. However, the numerous routes taken by juvenile salmonids emigrating through Lake Washington support the understanding that the juvenile PS Chinook salmon and juvenile PS steelhead that would annually emigrate through the project area would be small and variable subsets of their respective populations' cohorts. Further, the project's loudest noise sources would occur only briefly during a 10-month work window, and that in most cases, any areas ensonified above the threshold for the onset of effects would likely consist of small, 33- to 72-foot wide areas that would episodically exist across the project area. Consequently, the number of individuals that are likely to be meaningfully affected by the exposure would most likely comprise very small subsets of the total numbers of individuals that pass though the affected area. Therefore, the annual numbers of juvenile PS Chinook salmon and PS steelhead that would be meaningfully affected by this stressor would be too low to cause detectable population-level effects.

Work- and Structure-related Pollutants

Exposure to work-related pollutants is likely to adversely affect juvenile PS Chinook salmon, but cause only minor effects for adult Chinook salmon. Steelhead smolts and or adults are extremely unlikely to be exposed. Exposure to structure-related pollutants is likely to adversely affect juvenile PS Chinook salmon and juvenile PS steelhead, but cause only minor effects for adults of both species.

The proposed in-water work would temporarily affect water quality through increased turbidity, reduced dissolved oxygen, and the introduction of toxic materials from the mobilization of contaminated sediments and from equipment-related spills and discharges. Post-construction structure-related vessel operations would cause episodic temporary water quality impacts from leaks, spills, and other discharges from the vessels.

Turbidity: Pile and debris removal and tugboat propeller wash would mobilize bottom sediments that would cause episodic, localized, and short-lived turbidity plumes with relatively low concentrations of total suspended sediments (TSS). The intensity of turbidity is typically measured in Nephlometric Turbidity Units (NTU) that describe the opacity caused by the suspended sediments, or by the concentration of TSS as measured in milligrams per liter (mg/L). A strong positive correlation exists between NTU values and TSS concentrations. Depending on the particle sizes, NTU values roughly equal the same number of mg/L for TSS (i.e. 10 NTU = ~ 10 mg/L TSS, and 1,000 NTU = ~ 1,000 mg/L TSS) (Campbell Scientific Inc. 2008; Ellison et al. 2010). Therefore, the two units of measure are relatively comparable.

Water quality is considered adversely affected by suspended sediments when turbidity is increased by 20 NTU for a period of 4 hours or more (Berg and Northcote 1985; Robertson et al.

2006). The effects of turbidity on fish are somewhat species and size dependent. In general, severity typically increases with sediment concentration and duration of exposure, and decreases with the increasing size of the fish. Bjornn and Reiser (1991) report that adult and larger juvenile salmonids appear to be little affected by the high concentrations of suspended sediments that may be mobilized during storm and snowmelt runoff episodes. However, empirical data from numerous studies report the onset of minor physiological stress in juvenile and adult salmon after one hour of continuous exposure to suspended sediment concentration levels between about 1,100 and 3,000 mg/L, or to three hours of exposure to 400 mg/L, and seven hours of exposure to concentration levels as low as 55 mg/L (Newcombe and Jensen 1996). The authors reported that serious non-lethal effects such as major physiological stress and reduced growth were reported after seven hours of continuous exposure to 400 mg/L and 24 hours of continuous exposures to concentration levels as low as about 150 mg/L.

Vibratory removal of hollow 30-inch steel piles in Lake Washington mobilized sediments that adhered to the piles as they were pulled up through the water column (Bloch 2010). Turbidity reached a peak of about 25 NTU (~25 mg/L) above background levels at 50 feet from the pile, and about 5 NTU (~5 mg/L) above background at 100 feet. Turbidity returned to background levels within 30 to 40 minutes. Pile installation created much lower turbidity. The planned extraction of 13- to 14-inch diameter piles is extremely unlikely to mobilize as much sediment as described above because the piles have much smaller surface areas for sediments to adhere to. Therefore, the mobilization of bottom sediments, and resulting turbidity from the planned pile removal is likely to be less than that reported by Bloch. Additionally, all pile extraction would be done within full-depth sediment curtains that would reduce the spread of mobilized sediments, as well as the potential for fish to be exposed to it. The planned debris removal would also mobilize bottom sediments when. The applicant hasn't described the sediment layers on the debris or its embeddedness into the lake bed, but it is not expected to be very deep. Consequently, sediment mobilization from debris removal is also unlikely to exceed that reported by Bloch.

Tugboat and workboat propeller wash could also mobilize bottom sediments. The intensity and duration of the resulting turbidity plumes are uncertain, and would depend on a combination of the boat's thrust, the water depth under it, and the type of substrate. The higher the thrust, the shallower the water, and the finer the sediment, the more sediment that would be mobilized. Fine material (silt) remains mobilized longer than coarse material (sand). A recent study described the turbidly caused by large tugboats operating in Navy harbors (ESTCP 2016). At about 13 minutes, the plume extended about 550 yards (500 m) and had a TSS concentration of about 80 mg/L. The plume persisted for hours and extended far from the event, but the TSS concentration fell to 30 mg/L within 1 hour and to 15 mg/L within 3 hours. At its highest concentration, the plume was below the concentrations required to elicit physiological responses reported by Newcombe and Jensen (1996). The exact extent of turbidly plumes from project-related tugboat and workboat operations are unknown, but it is extremely unlikely that they would rise to the levels described above. Project-related tugboat trips would be infrequent, and would likely last a low number of hours while they reposition work barges. Workboat operations would likely be more frequent, but would also involve smaller, less powerful propulsion systems. Therefore, the resulting propeller wash turbidity plumes would be low in number, episodic, and of relatively low intensity. Based on the information above, and on numerous consultations for similar projects in the region, sediment mobilization from tugboat and workboat propeller wash would likely consist of relatively low-concentration plumes that could extend up to about 300 feet from the site, and last a low number of hours hour after the disturbance ends.

The most likely effects of salmonid exposure to work-related turbidity would be temporary behavioral effects such as avoidance of the plume, mild gill flaring, and slightly reduced feeding rates in juveniles during the exposure.

Dissolved Oxygen: Mobilization of anaerobic sediments can decrease dissolved oxygen levels (Hicks et al. 1991; Morton 1976). Sediment's impact on dissolved oxygen is a function of the oxygen demand of the sediment, the amount of material suspended in the water, the duration of suspension, and the water temperature (Lunz and LaSalle 1986; Lunz et al. 1988). Reduced dissolved oxygen can affect salmonid swimming performance (Bjornn and Reiser 1991), as well as cause avoidance of water with low dissolved oxygen levels (Hicks 1999). However, the small amount of sediments that would be mobilized by pile and debris removal suggests that any dissolved oxygen reductions would be too small and short-lived to cause more than minor behavioral effects, such as avoidance of the turbidity plume, in exposed fish. Additionally, all pile extraction would be done within full-depth sediment curtains that would reduce the potential for fish exposure to waters with reduced dissolved oxygen levels related to that work.

Toxic Materials: Pile removal and tugboat/workboat propeller wash would mobilize contaminated sediments, PAHs may be released from creosote-treated timber piles that break during their removal. Toxic materials may also enter the water through spills and discharges from work-related equipment and vessels, and from structure-related vessel operation.

No sediment contamination has been identified at the project site (WDOE 2023), but the project site has been used for vessel operations since 1889, and has been a marina since 1905. That long history of boat operations and the presence of creosote-treated timber piles supports the belief that at least some level of sediment contamination likely exists. At a minimum, creosote-treated piles leach PAHs into the surrounding sediments, as well as directly into the water (Evans et al. 2009; Parametrix 2011; Smith 2008; Werme et al. 2010). Therefore, the sediments that would be mobilized at the site would contain some level of PAHs from the creosote-treated piles, and other legacy pollutants are also very likely present. PAHs may also be released directly into the water by timber piles that break during their removal. The in-water pollutant concentrations that may result are uncertain, but are likely to be low, and most of the mobilized sediments would be contained within full-depth sediment curtains that would also likely act as fish exclusion devices. However, tugboat and workboat operations after the sediment curtains are removed could remobilize some contaminated sediments and distribute them up to 300 feet around the project site.

The operation of construction equipment, tugboats, and recreational vessels routinely results in small leaks and spills of fuels, lubricants, and other fluids that can enter the water. Occasionally, larger spills and discharges occur. Many of the fuels, lubricants, and other fluids commonly used in construction equipment and vessels are petroleum-based hydrocarbons that contain PAHs, PCBs, phlalates, other organic compounds, and metals. Additionally, anti-fouling hull paints leach copper.

The project includes BMPs specifically intended to reduce the risk and intensity of discharges and spills. In the event of a work-related spill or discharge, the event would likely be relatively small, and quickly contained and cleaned. Based on the best available information, the in-water presence of pollutants related to equipment and vessel operation would be infrequent, short-lived, and at relatively low concentrations. No specific measures are in place to limit leaks and spill from structure-related vessels. However, based on the relatively small size of the vessels that would use the new structures (typically less than 30 feet in length), on the short-term nature of their moorage, and the absence of fueling facilities at the structures, the in-water presence of pollutants related to structure-related vessel operation would also be infrequent, short-lived, and at relatively low concentrations.

PS Chinook salmon and other fish can uptake pollutants directly through their gills, and through dietary exposure (Karrow et al. 1999; Lee and Dobbs 1972; McCain et al. 1990; Meador et al. 2006; Neff 1982; Varanasi et al. 1993). Impacts via the trophic web are discussed below, under forage diminishment.

Depending on the pollutant, its concentration, and or the duration of exposure, exposed fish may experience effects that can range from avoidance of an affected area, to reduced growth, altered immune function, and mortality (Beitinger and Freeman 1983; Brette et al. 2014; Feist et al. 2011; Gobel et al. 2007; Incardona et al. 2004, 2005, and 2006; McIntyre et al. 2012; Meadore et al. 2006; Sandahl et al. 2007; Spromberg et al. 2015). PAHs can cause reduced growth, increased susceptibility to infection, and increased mortality in juvenile salmonids (Eisler 1987; Meador et al. 2006; Varanasi et al. 1993). Gill tissues are highly susceptible to damage because they actively pass large volumes of water and are thereby exposed to PAHs present in water (USACE 2016). Other effects include damage to the skin, fins, and eyes, as well as damage to internal organs as liver tumors. In freshwater, exposure to dissolved copper at concentrations between 0.3 to 3.2 µg/L above background levels has been shown to cause avoidance of an area, to reduce salmonid olfaction, and to induce behaviors that increase juvenile salmon’s vulnerability to predators (Giattina et al. 1982; Hecht et al. 2007; McIntyre et al. 2012; Sommers et al. 2016; Tierney et al. 2010). The most likely effects of salmonid exposure to work- and structure-related waterborne toxic materials would be non-lethal, such as temporary avoidance of the affected area, which is not expected to exceed 300 feet around the replacement structures. However, fitness impacts such as those described above would become increasingly likely with increased proximity to the source and or duration of exposure.

<u>Work-related Pollutant Effects:</u> The exact timing of the various work components and how they might overlap with the presence of Chinook salmon is uncertain. Consequently, to avoid underestimating impacts, this assessment assumes that both juvenile and adult Chinook salmon could be exposed to any of the work-related pollutant sources. For the same reasons expressed above under work-related noise effects, it is it is extremely unlikely that adult Chinook salmon would experience anything more than minor behavioral responses that would cause no meaningful impacts on their fitness or normal behaviors.

Conversely, the juvenile Chinook salmon that migrate along the east side of the lake from south of the project site would be behaviorally driven to follow as close to shore as possible as they pass through the project area. The most likely response of juvenile Chinook salmon that are exposed to action-attributable pollutants would be non-lethal behavioral effects such as temporary avoidance of the affected area, which is not expected to exceed 300 feet around the replacement structures. However, serious fitness impacts, as described above, would become increasingly likely with increased proximity to the source and or duration of exposure.

Structure-related Pollutant Effects: Because structure-related vessel operations could occur at any time of the year, and over several decades after construction, this assessment assumes that juvenile and adult Chinook salmon and steelhead could be exposed to the pollutants from structure-related vessel operations. For the same reasons expressed above under work-related noise effects, it is it is extremely unlikely that adult Chinook salmon or steelhead would experience anything more than minor behavioral responses that would cause no meaningful impacts on their fitness or normal behaviors. However, juvenile Chinook salmon that migrate along the east side of the lake from south of the project site would be compelled to swim through the project area. Also, over the decades-long lives of replacement structures, low numbers of steelhead smolt may pass through the project area.

The most likely response of juvenile Chinook salmon and steelhead that are exposed to structure-related pollutants would also be non-lethal behavioral effects such as temporary avoidance of the affected area, which is not expected to exceed 300 feet around the replacement structures, with serious fitness impacts becoming increasingly likely with increased proximity to the source and or duration of exposure.

In summary, the proposed action would impact water quality through episodic and temporary work-related increases in turbidity and slight reductions in dissolved oxygen concentrations, and through slight increases in toxic material concentrations related to work and to structure-related vessel operations. The resulting pollutant concentrations are undeterminable with the available information, but are very unlikely to exceed thresholds for acute injuries or mortality. However, exposed juveniles would likely experience some combination of areal avoidance, gill flaring, reduced feeding rates, and reduced swimming performance. At close proximity and extended exposure durations, some exposed individuals may experience long-term fitness impacts such as reduced growth, altered immune function, and tissue damage that could reduce their long-term survival.

The annual numbers of juvenile PS Chinook salmon and juvenile PS steelhead that may be exposed to this stressor are unquantifiable with any degree of certainty. However, for the same reasons as stated under work- and structure-related noise, the the juvenile PS Chinook salmon and juvenile PS steelhead that would annually emigrate through the project area would be small and variable subsets of their respective populations' cohorts. Further, the numbers of individuals that are likely to be measurably affected by the exposure would most likely comprise small subsets of the total number of individuals that pass through the project area. Therefore, the annual numbers of juvenile PS Chinook salmon and PS steelhead that would be meaningfully affected by this stressor would be too low to cause detectable population-level effects.

Work- and Structure-related Propeller Wash

Exposure to work-related propeller wash is likely to adversely affect juvenile PS Chinook salmon, but cause only minor effects for adult Chinook salmon. Steelhead smolts and or adults are extremely unlikely to be exposed. Exposure to structure-related pollutants is likely to adversely affect juvenile PS Chinook salmon and juvenile PS steelhead, but cause only minor effects for adults of both species.

The proposed work would include the use of tugboats and work boats. The replacement structures would support the short-term moorage of about 50 vessels, most of which are expected to be powerboats about 24 feet long. These vessel operations would involve spinning propellers in the nearshore waters of the project area. Spinning boat propellers kill fish and small aquatic organisms (Killgore et al. 2011; VIMS 2011). Spinning propellers also generate fast-moving turbulent water (propeller wash) that can displace and disorient small fish, as well as dislodge benthic aquatic organisms and submerged aquatic vegetation (SAV), particularly in shallow water and or at high power settings (propeller scour).

For the same reasons stated above for work-related noise, steelhead are extremely unlikely to be present during the project's in-water work window. However, over the decades-long life of the replacement structures, it is reasonably likely that some steelhead smolts and adults would enter the project area, where they might be exposed to structure-related propeller wash, which would occur year-round. Juvenile Chinook salmon and steelhead in the action area would be relatively small, and likely to remain close to the surface where they could be exposed to spinning propellers and powerful propeller wash near the structures. Conversely, adults of both species would tend to swim offshore and below the surface, and they would be able to swim against most propeller wash they might be exposed to, without experiencing any measurable effect on their fitness or normal behaviors.

Juvenile salmonids that are struck or very nearly missed by the spinning propellers would be injured or killed by the exposure. At greater distances, the boats' propeller wash may displace and disorient fish. Depending on the direction and strength of the thrust plume, displacement could increase energetic costs, reduce feeding success, and increase the vulnerability to predators for individuals that tumble stunned and or disoriented in the wash. Although the likelihood of this interaction would be very low for any individual fish or individual boat operation, over the extended lives of the replacement structures, at least some juvenile PS Chinook salmon and juvenile PS steelhead would experience reduced fitness or mortality from exposure to spinning propellers and or propeller wash that would be attributable to those structures.

There would be some differences between work- and structure-related propeller wash. Work-related propeller wash is more likely to include episodic events by larger vessels, like tugboats, over a single 10-month period, large portions of which would likely be during periods when salmonids wouldn't be present. Conversely, structure-related propeller wash would occur anytime during a given year for decades to come, and would mostly involve powerboats under 30 feet in length. However, the summertime peak in recreational vessel use would occur after virtually all juvenile salmonids have left the Lake.

The annual numbers of juvenile PS Chinook salmon and PS steelhead that would be exposed to this stressor, and the intensity of any effects that an exposed individual may experience are unquantifiable with any degree of certainty. However, for the same reasons expressed under work- and structure-related noise, the juvenile PS Chinook salmon and juvenile PS steelhead that would annually emigrate through the project area would be small and variable subsets of their respective populations' cohorts. Further, the typically episodic and short-duration of vessel operations of vessel operations at moorage facilities, combined with the knowledge that the peak boating season occurs after the juveniles have left the ship canal suggests that the probability of exposure to propeller wash would be extremely low for any individual fish that passes through the project area. Additionally, the numbers of individuals that would be meaningfully affected by the exposure would most likely comprise small subsets of the total number of exposed individuals. Therefore, the annual numbers of PS Chinook salmon and PS steelhead that would be adversely affected by action-attributable propeller wash would be too low to cause detectable population-level effects.

Action-related propeller scour, would likely be limited to the operation of work-related vessels, and is likely to slightly reduce SAV and diminish the density and diversity of the benthic community at the project site, particularly when operating in the shallower water closer to shore. The exact number and sizes of the affected areas are uncertain, but they are expected to be relatively small compared the size of the total project area. Although the SAV and other benthic organisms would eventually recover, it could take a low number of years to return to pre-impact functionality. During that time, the reduced cover availability normally provided by the lost SAV may slightly increase juvenile salmonid vulnerability to predation, and act synergistically with the other vectors of increased vulnerability, such as noise and altered lighting discussed above and below. However, the intensity of this effect would be low to cause any detectable population effects. Additionally, reduced SAV and invertebrate availability due to propeller scour would also reduce the availability and quality of forage resources for migrating juvenile salmonids, which is discussed in more detail under forage diminishment.

<u>Structure-related Altered Lighting</u>

Exposure to the effects of structure-related altered lighting is likely to adversely affect juvenile PS Chinook salmon and juvenile PS steelhead, but cause minor effects in adults of both species.

The replacement structures and the vessels moored to them would create unnatural daytime shade, and artificial illumination at night. The replacement structures would consist of two interconnected over-water structures with a combined over-water area of about 10,582 square feet (Figure 3). The proposed public access pier would consist of a fully-grated 3,982-square foot pier, ramp, and float structure that would extend about 320 feet perpendicularly to the shoreline. The grating would have 60% open area, and the structure would extend over water depths of about 0 to 40 feet deep during low water. The proposed 550-foot long, wave attenuator would be solid-decked, and have a 6,600-square foot over-water area. It would extend roughly parallel to the shoreline, about 320 feet from shore at its closest, over water at least 40 feet deep during low water.

Shade: The replacement structures and the vessels moored to them would create unnatural daytime shade over the water and aquatic substrate. The intensity of shadow effects of the replacement structures and the vessels moored to them is likely to vary based on the brightness and angle of the sun. They would be most intense on sunny days, and less pronounced to possibly inconsequential on cloudy days.

The over-water footprint of the replacement public access pier would be 3,049 square feet smaller than the existing 7,031-square foot solid-decked structure. Due to its much smaller size and fully-grated decking, the shade of the replacement public access pier would be much less than that of the existing structure. However, its shade, and the shade of the vessels moored to it would create conditions under and adjacent to its footprint that would reduce aquatic productivity, alter juvenile salmonid migratory behaviors, and increase juvenile salmonids' exposure and vulnerability to predators as compared to unshaded similar habitat. The 6,600-square foot, solid-decked wave attenuator and the boats moored to it would create additional shade.

Shade limits primary productivity and can reduce the diversity of the aquatic communities under over-water structures (Nightingale and Simenstad 2001; Simenstad et al. 1999). Because the water and substrate under the replacement structures would be more supportive of SAV and benthic invertebrates without those structures' shade, that shade would continue to reduce the availability and quality of natural cover and forage for juvenile salmonids at the project site.

The shade-related SAV reduction would also reduce the availability of natural cover under and adjacent to the structures, which would increase juvenile salmonids' exposure and vulnerability to piscivorous predatory fish that frequently reside in the shadows of over-water structures. The effects of increased exposure and vulnerability to predators is discussed in more detail after the analysis of shade-related migratory impacts below. Shade-related reduced productivity would also reduce the availability and quality of forage resources for migrating juvenile salmonids, which is discussed in more detail under forage diminishment.

The shade of over-water structures also negatively affects juvenile salmonid migration. Numerous studies demonstrate that juvenile salmonids, in both freshwater and marine habitats, are more likely to avoid an overwater structure's shadow than to pass through it (Celedonia et al. 2008a and b; Kemp et al. 2005; Moore et al. 2013; Munsch et al. 2014; Nightingale and Simenstad 2001; Ono et al. 2010; Southard et al. 2006; Tabor et al. 2006).

Therefore, the shade of the replacement structures is likely to continue altering the migratory behavior for at least some of the juvenile Chinook salmon that pass through the project area. It would inhibit some from migrating along the shoreline, which is typical behavior for juvenile Chinook salmon emigrating from freshwater. The shade would delay the passage under the structures for some, and or induce some individuals to swim around the structures, effectively forcing them to remain in open and relatively deep waters. The off-bank migration of these small fish increases migration distance and time, which has been positively correlated with increased mortality in juvenile Chinook salmon (Anderson et al. 2005), and it increases energetic costs (Heerhartz and Toft 2015). Shade-related altered migratory behaviors would mostly affect juvenile PS Chinook salmon, because the juvenile PS steelhead that would annually pass the project area would be relatively large and shoreline independent.

Additionally, shade and deep water both favor freshwater predatory species, such as smallmouth bass and northern pikeminnow that are known to hide under over-water structures, and to prey heavily on juvenile salmonids (Celedonia et al. 2008a; Tabor et al. 2010). The deeper water away from the bank also increases the risk of predation for migrating juvenile salmonids (Willette 2001). Further, the reduced availability of natural cover, identified above, under shade-related reduced SAV production, would limit shelter resources for juvenile salmonids, which increases their exposure and vulnerability to predatory fish. Therefore, juvenile PS Chinook salmon and juvenile PS steelhead that are in close proximity to the repaired pier would be at more risk of predation than they would be in the pier's absence.

Artificial Illumination: The replacement structures and the vessels moored to them would have lighting systems that would cause nighttime artificial illumination of lake waters. Nighttime artificial illumination of the water's surface attracts fish (positive phototaxis) in marine and freshwater environments, it often shifts nocturnal behaviors toward more daylight-like behaviors, and it can affect light-mediated behaviors such as migration timing (Becker et al. 2013; Celedonia and Tabor 2015; Ina et al. 2017; Tabor and Piaskowski 2002; Tabor et al. 2017).

Tabor and Piaskowski (2002) report that juvenile Chinook salmon in lacustrine environments typically feed and migrate during the day, and are inactive at night, residing at the bottom in shallow waters. They tend to move off the bottom and become increasingly active at dawn when light levels reach 0.8 to 2.1 lumens per square meter. Tabor et al. (2017) found that sub-yearling Chinook, coho, and sockeye salmon exhibit strong nocturnal phototaxic behavior when exposed to levels of 5.0 to 50.0 lumens per square meter, with phototaxis positively correlated with light intensity. Celedonia and Tabor (2015) found that juvenile Chinook salmon in the Lake Washington Ship Canal were attracted to artificially lit areas at 0.5 to 2.5 lumens per square meter. The authors also reported that attraction to artificial lights may delay the onset of morning migration by up to 25 minutes for some juvenile Chinook salmon migration through the Lake Washington Ship Canal.

The proposed public access pier would have 18 low-intensity, louvered lights with frosted lenses, installed along both sides of the gangway railings, plus 3 3.5-foot tall pedestals with low-level bollard lighting, and 2 12-foot tall light poles on the float. The wave attenuator would have 7 3.5-foot tall pedestals with low-level bollard lighting, and 11 12-foot tall light poles. Moored vessels are also likely to be episodically illuminated at night, and many are likely to illuminate the water surface at levels above 0.5 lumens. However, those incidences would most likely occur during the summer boating season after juvenile salmon have departed the lake, and they would be limited to relatively brief periods (minutes to low numbers of hours) that would be unlikely to cause anything more than short-lived minor phototaxis. Therefore, it is very unlikely that artificial illumination from the repaired portions of the marinas would cause any measurable effects on the fitness of exposed individuals, or cause any meaningful change in their normal behaviors.

The applicant provided no specific luminosity information about the proposed lighting systems. In its absence, to avoid underestimating potential impacts on listed fish, this assessment assumes that artificial lighting from the replacement structures and or the vessels moored to them would illuminate the water's surface at intensities above 0.5 lumens per square meter out as far as about

50 feet from the illuminated structures. Therefore, action-related artificial illumination is likely to cause phototaxis and delayed morning migration for some juvenile Chinook salmon and juvenile steelhead that are within that distance.

In summary, structure-related altered lighting would cause some combination of altered behaviors and increased risk of predation that would reduce fitness or cause mortality for some juvenile PS Chinook salmon and juvenile PS steelhead that pass the project site. The annual numbers of either species that may be exposed to this stressor are unquantifiable with any degree of certainty, and are likely to be highly variable over time. However, the best available information about the routes taken by juvenile salmonids emigrating through Lake Washington support the understanding that the juvenile PS Chinook salmon and juvenile PS steelhead that would annually emigrate through the project area would be small and variable subsets of their respective populations' cohorts. Further, the number of individuals that are likely to be meaningfully affected by the exposure would most likely comprise a small subset of the total number of the individuals that pass though the affected area. Therefore, the annual numbers of juvenile PS Chinook salmon and PS steelhead that would be meaningfully affected by this stressor would be too low to cause detectable population-level effects.

<u>Work- and Structure-related Forage Diminishment</u>

Forage diminishment is likely to adversely affect juvenile PS Chinook salmon and juvenile PS steelhead. It is extremely unlikely that adults of either species would be exposed to this stressor.

Juvenile Chinook salmon and steelhead annually emigrate through lake Washington, with some subset of each year's cohort passing through the project area. As stated earlier, the emigrating juvenile Chinook salmon would be biologically compelled to stay close to the shoreline. Emigrating juvenile steelhead are much less tied to shoreline habitats, but over the years-long effects of the project, some emigrating juvenile steelhead are also likely to pass through the project area. During those emigrations, the juveniles would be nearly constantly foraging on available planktonic organisms such as amphipods, copepods, and euphausiids, as well as the larvae of benthic species and fish (NMFS 2006).

As identified under Work- and Structure-related Pollutants, Work- and Structure-related Propeller Wash, and Structure-related Altered Lighting, the proposed work, the replacement structures, and vessel operations at the structures are all likely to reduce the quality and or availability of forage organisms at the project site.

<u>Forage Contamination:</u> Pile removal is likely to mobilize contaminated sediments, work-related tugboat operations are likely to mobilize and or spread contaminated sediments, and work- and structure-related vessel and equipment operations are likely to introduce pollutants though spills and other discharges. The project would extract 68 piles, including 52 creosote-treated timber piles. At least 52 of the extractions are likely to mobilize PAH-contaminated subsurface sediments (Evans et al. 2009) that would settle onto the top layer of the lake bed. Romberg (2005) discusses the spread and deposition of contaminated sediments that were mobilized by pile removal from contaminated sediments. After the work, elevated PAH, lead, and mercury levels were detected on the surface of a previously clean sand cap at an adjacent site. Pollutant

concentrations decreased with distance from the work site, and over time. However, PAH concentrations remained above pre-contamination levels 10 years later, whereas lead and mercury values decreased to background levels after 3 years.

The pile-extraction would occur within full-depth sediment curtains. Consequently, most mobilized sediments are likely to settle back to the lake bed close to where the piles were extracted. However, some of those contaminated sediments may be remobilized by tugboat propeller wash. As such, pollutant concentrations would likely be highest within the areas under and immediately adjacent to the structures to be replaced, diminishing with distance out to about 300 feet away. Within the affected area, the pollutants would be biologically available at decreasing levels for years. While present, some of those pollutants are likely to be taken up by benthic infaunal and epifaunal invertebrate organisms within the affected area.

The operation of construction equipment, tugboats, and recreational vessels are likely to involve leaks and spills of fuels, lubricants, and other fluids that can enter the water. Many of the fuels, lubricants, and other fluids commonly used in construction equipment and vessels are petroleum-based hydrocarbons that contain PAHs, PCBs, phlalates, other organic compounds, and metals. Some of those pollutants are likely to settle to lakebed.

Fish can absorb pollutants through dietary exposure as well as through direct uptake through their gills, (Meador et al. 2006; Varanasi et al. 1993). Amphipods and copepods uptake pollutants such as PAHs from contaminated sediments (Landrum and Scavia 1983; Landrum et al. 1984; Neff 1982), and pass them to juvenile Chinook salmon and other small fish through the food web. Varanasi et al. (1993) found high levels of PAHs in the stomach contents of juvenile Chinook salmon in the contaminated Duwamish Waterway. They also reported reduced growth, suppressed immune competence, as well as increased mortality in juvenile Chinook salmon that was likely caused by the dietary exposure to PAHs. Meador et al. (2006) demonstrated that dietary exposure to PAHs caused "toxicant-induced starvation" with reduced growth and reduced lipid stores in juvenile Chinook salmon. The authors surmised that these impacts could severely impact the odds of survival in affected juvenile Chinook salmon. Although not specifically addressed by the authors, the biological similarity between Chinook salmon and steelhead suggests that steelhead may be similarly affected.

<u>Reduced Forage Availability:</u> In addition to forage contamnation, the action-attributable in-water and sediment pollutant levels at the site may also sicken or kill some planktonic and benthic organisms, diminishing the number, size, and diversity of available salmonid prey organisms within the affected area.

Although the size and intensity of the replacement structures' shadows would be smaller and less intense that the existing structures, the shade of the replacement structures and their moored vessels would continue to cause conditions that would maintain a state of slightly reduced productivity that would also act reduce the availability, diversity, and quality of the SAV and benthic organisms under and slightly adjacent to the replacement structures.

The propeller wash from work-related tugboat operations is likely to impact some parts of the lakebed with enough thrust to wash away (scour) SAV and benthic organisms. This would most likely occur infrequently, and cause a low number of relatively small areas where SAV and benthic organisms would be removed. If left undisturbed, the affected areas would recover over time, but it could take a year or more before the affected areas return to per-construction conditions, and the recovery the affected benthic communities, especially those under and or immediately adjacent to the replacement structures could be delayed by the impacts of work- and structure-related pollutants and structure-related altered lighting.

Summary: The proposed action would cause low levels of forage contamination and or reduced forage availability that could reduce the fitness and long-term survivability of some of the juvenile Chinook salmon and juvenile steelhead that swim through the project area.

The annual numbers of either species that may be exposed to this stressor are unquantifiable with any degree of certainty, and are likely to be highly variable over time. Similarly, the amount of action-attributable contaminated prey that any individual fish may consume, the contamination levels in consumed prey, the amount of reduced prey availability, and or the intensity of any effects that an exposed individual may experience are uncertain and likely to be highly variable over time.

Based on the knowledge that emigrating juveniles of both species follow multiple routes through Lake Washington, the PS Chinook salmon and PS steelhead that would annually pass through the project area would be subsets of their cohorts. Further, the affected area would be relatively small, and much of it would occur at water depths and distances from shore that are atypical for emigrating juvenile Chinook salmon (offshore and deep). This supports the expectation that any exposure to the affected area would be brief, and the probability of meaningful trophic connectivity to forage diminishment would be very low for any individual fish passing though the project area.

Therefore, the individuals that would be meaningfully affected would likely comprise very small subsets of the total numbers of individuals that would annually pass through the affected area. Based on the available information, the annual numbers of PS Chinook salmon and PS steelhead that would be meaningfully affected by action-related forage diminishment would be too small to cause detectable population-level effects.

2.5.2 Effects on Critical Habitat

This assessment considers the intensity of expected effects in terms of the change they would cause in affected Primary Biological Features (PBFs) from their baseline conditions, and the severity of each effect, considered in terms of the time required to recover from the effect. Ephemeral effects are those that are likely to last for hours or days, short-term effects would likely last for weeks, and long-term effects are likely to last for months, years or decades.

Critical Habitat for PS Chinook salmon: The proposed action, including full application of the planned conservation measures and BMPs, is likely to adversely affect designated critical habitat for PS Chinook salmon as described below.

1. Freshwater spawning sites: – Outside of the expected range of detectable effects.

2. Freshwater rearing sites: – Outside of the expected range of detectable effects.

3. Freshwater migration corridors free of obstruction and excessive predation:
   a. Obstruction and excessive predation – The proposed project would cause minor short- and long-term adverse effects, and minor long-term beneficial effects on this attribute. Work-related in-water noise, and structure-related in-water noise and altered light would create and or maintain conditions at the site that are likely to slightly alter normal migration behaviors, and slightly increase the risk of predation for juvenile Chinook salmon that migrate past the project area. The removal of sunken debris is likely to reduce predator-supportive features within the marina.
   b. Water quantity – The proposed project would cause no effect on this attribute.
   c. Water quality – The proposed action would cause minor short- and long-term adverse and beneficial effects on this attribute. Demolition and construction would cause short-term adverse effects on water quality that would be mostly contained within full-depth sediment curtains, and would persist no more than a low number of hours after work stops. Also, vessel moorage at the replacement structures would include persistent low-level inputs of pollutants. Conversely, the permanent removal of 52 creosote-treated timber piles would reduce ongoing PAH contamination at the site, and the removal of sunken debris is likely to reduce the presence of some toxic materials that are likely leaching into the water. Detectable water quality impacts are expected to be limited to the area within 300 feet around the project site. The action would cause no measurable changes in water temperature or salinity.
   d. Natural Cover – The proposed action would cause minor long-term adverse effects, and minor long-term beneficial effects on this attribute. Work-related tugboat propeller scour is likely to slightly reduce SAV availability at the project site, which could take more than a year to recover. Additionally, the shade from the replacement structures would perpetuate conditions that act to limit the growth of SAV. However, compared to the existing conditions, the project would increase light penetration at the site by reducing the size of the pier and by transitioning from solid-plank decking to fully-grated decking, and by installing the solid-decked wave attenuator over 40-foot+ deep water, more than 300 feet from shore. The removal of sunken debris is likely to reduce predator-supportive artificial features within the marina, and it may slightly improve the affected area's ability to support native SAV.

4. Estuarine areas free of obstruction and excessive predation: – Outside of the expected range of detectable effects.

5. Nearshore marine areas free of obstruction and excessive predation: – Outside of the expected range of detectable effects.

6. Offshore marine areas: – Outside of the expected range of detectable effects.

2.6 Cumulative Effects

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

Some continuing non-Federal activities are reasonably certain to contribute to climate effects within the action area. However, it is difficult if not impossible to distinguish between the action area's future environmental conditions caused by global climate change that are properly part of the environmental baseline *vs.* cumulative effects. Therefore, all relevant future climate-related environmental conditions in the action area are described in the discussion of the environmental baseline (Section 2.4).

The current conditions of ESA-listed species and designated critical habitat within the action area are described in the Range-wide Status of the Species and Critical Habitat and Environmental Baseline sections above. The non-federal activities in and upstream of the action area that have contributed to those conditions include past and on-going bankside development, vessel activities, and upland urbanization, as well as upstream forest management, agriculture, road construction, water development, subsistence and recreational fishing, and restoration activities. Those actions were, and continue to be, driven by a combination of economic conditions that characterized traditional natural resource-based industries, general resource demands associated with settlement of local and regional population centers, and the efforts of conservation groups dedicated to restoration and use of natural amenities, such as cultural inspiration and recreational experiences.

The NMFS is unaware of any specific future non-federal activities that are reasonably certain to affect the action area. However, the NMFS is reasonably certain that future non-federal actions such as the previously mentioned activities are all likely to continue and increase in the future as the human population continues to grow across the region. Continued habitat loss and degradation of water quality from development and chronic input from point- and non-point pollutant sources will likely continue and increase into the future. Recreational and commercial use of the waters within the action area are also likely to increase as the human population grows.

The intensity of these influences depends on many social and economic factors, and therefore is difficult to predict. Further, the adoption of more environmentally acceptable practices and standards may gradually reduce some negative environmental impacts over time. Interest in restoration activities has increased as environmental awareness rises among the public. State, tribal, and local governments have developed plans and initiatives to benefit ESA-listed PS Chinook salmon and PS steelhead. However, the implementation of plans, initiatives, and specific restoration projects are often subject to political, legislative, and fiscal challenges that increase the uncertainty of their success.

2.7 Integration and Synthesis

The Integration and Synthesis section is the final step in assessing the risk that the proposed action poses to species and critical habitat. In this section, we add the effects of the action (Section 2.5) to the environmental baseline (Section 2.4) and the cumulative effects (Section

2.6), taking into account the status of the species and critical habitat (Section 2.2), to formulate the agency's biological opinion as to whether the proposed action is likely to: (1) reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing its numbers, reproduction, or distribution; or (2) appreciably diminish the value of designated or proposed critical habitat as a whole for the conservation of the species.

As described in more detail above in Section 2.4, climate change is likely to increasingly affect the abundance and distribution of the ESA-listed species considered in the opinion. It is also likely to increasingly affect the PBFs of designated critical habitats. The exact effects of climate change are both uncertain, and unlikely to be spatially homogeneous. However, climate change is reasonably likely to cause reduced instream flows in some systems, and may impact water quality through elevated in-stream water temperatures and reduced dissolved oxygen, as well as by causing more frequent and more intense flooding events.

Climate change may also impact coastal waters through elevated surface water temperature, increased and variable acidity, increasing storm frequency and magnitude, and rising sea levels. The adaptive ability of listed-species is uncertain, but is likely reduced due to reductions in population size, habitat quantity and diversity, and loss of behavioral and genetic variation.

The proposed action will cause direct and indirect effects on the ESA-listed species and critical habitats considered in this opinion well into the foreseeable future. However, the action's effects on water quality, substrate, and the biological environment are expected to be of such a small scale that no detectable effects on ESA-listed species or critical habitat through synergistic interactions with the impacts of climate change are expected.

2.7.1 ESA Listed Species

PS Chinook salmon and PS steelhead are both listed as threatened based on declines from historic levels of abundance and productivity, loss of spatial structure and diversity, and an array of limiting factors as a baseline habitat condition. Both species will be affected over time by cumulative effects, some positive – as recovery plan implementation and regulatory revisions increase habitat protections and restoration, and some negative – as climate change and unregulated or difficult to regulate sources of environmental degradation persist or increase. Overall, to the degree that habitat trends are negative, the effects on viability parameters of each species are also likely to be negative. In this context we consider how the proposed action's impacts on individuals would affect the listed species at the population and ESU/DPS scales.

PS Chinook salmon

The long-term abundance trend of the PS Chinook salmon ESU is slightly negative. Reduced or eliminated accessibility to historically important habitat, combined with degraded conditions in available habitat due to land use activities appear to be the greatest threats to the recovery of PS Chinook salmon. Commercial and recreational fisheries also continue to impact this species. The most recent 5-year status review reported a general decline in natural-origin spawner abundance across all PS Chinook salmon MPGs over the most-recent fifteen years. It also reported that escapement levels remain well below the PSTRT planning ranges for recovery for all MPGs, and concluded that the PS Chinook salmon ESU remains at "moderate" risk of extinction (Ford 2022).

The PS Chinook salmon most likely to occur in the action area would be fall-run Chinook salmon from the Cedar River and the Sammamish River populations, both of which are part of the South Puget Sound MPG. Both populations are considered at high risk of extinction due to low abundance and productivity.

The project site is located along the west bank of Lake Washington (Figure 1), which serves as a freshwater migration route to and from marine waters for adult and juvenile PS Chinook salmon from both affected populations. The environmental baseline within the action area has been degraded by the effects of nearby intense bankside development and maritime activities, and by nearby and upstream industry, urbanization, agriculture, forestry, water diversion, and road building and maintenance.

The action's in-water work window overlaps with the normal migration season for returning adult PS Chinook salmon and the pre-peak part of emigration season for juveniles. The proposed work would cause a range of effects that both individually and collectively would cause altered behaviors and possible mortality in extremely low numbers of juveniles. Additionally, over the next several decades, low numbers of emigrating juveniles that pass through the project site would be exposed to slightly altered habitat conditions and slightly diminished forage resources that individually and collectively would cause some combination of altered behaviors, reduced fitness, and mortality in some of the exposed individuals. However, the annual numbers of individuals that would be detectably affected by action-related stressors would be too low to cause any population-level effects.

Based on the best available information, the scale of the direct and indirect effects of the proposed action, when considered in combination with the degraded baseline, cumulative effects, and the impacts of climate change, would be too small to cause detectable effects on any of the characteristics of a viable salmon population (abundance, productivity, distribution, or genetic diversity) for the affected PS Chinook salmon populations. Therefore, the proposed action would not appreciably reduce the likelihood of survival and recovery of this listed species.

<u>PS steelhead</u>

The long-term abundance trend of the PS steelhead DPS is negative, especially for natural spawners. Abundance information is unavailable for about 1/3 of the DIPs. In most cases where no information is available, abundances are assumed to be very low. Although most DIPs for which data are available experienced improved abundance over the last five years, 95% of those DIPs are at less than half of their lower abundance target for recovery. The extinction risk for the Puget Sound steelhead DPS is considered moderate. Reduced or eliminated accessibility to historically important habitat, combined with degraded conditions in available habitat due to land use activities appear to be the greatest threats to the recovery of PS steelhead. Fisheries activities also continue to impact this species Ford 2022.

The PS steelhead most likely to occur in the action area would be winter-run fish from the Cedar River DIP, and North Lake Washington and Lake Sammamish DIP. The Cedar River PS steelhead DIP is small, of unknown stock with natural production, but with a strongly negative long-term abundance trend. The North Lake Washington and Lake Sammamish DIP is extremely small, of unknown stock origin, with less than 10 adults retuning annually since 1994.

The project site is located along the west bank of Lake Washington (Figure 1), which serves as a freshwater migration route to and from marine waters for adult and juvenile PS steelhead from both affected DIPs. The environmental baseline within the action area has been degraded by the effects of nearby intense bankside development and maritime activities, and by nearby and upstream industry, urbanization, agriculture, forestry, water diversion, and road building and maintenance.

Based on the rarity of PS steelhead in the watershed, combined with the small project area and the relatively short duration of the project's in-water work, it is extremely unlikely that any steelhead would be directly exposed to work-related effects. However, over the next several decades, extremely low numbers of emigrating juveniles are likely to pass through the project site where they would be exposed to slightly altered habitat conditions and slightly diminished forage resources that individually and collectively would cause some combination of altered behaviors, reduced fitness, and mortality in some of the exposed individuals. However, the annual numbers of individuals that would be detectably affected by action-related stressors would be too low to cause any population-level effects.

Based on the best available information, the scale of the direct and indirect effects of the proposed action, when considered in combination with the degraded baseline, cumulative effects, and the impacts of climate change, would be too small to cause detectable effects on any of the characteristics of a viable salmon population (abundance, productivity, distribution, or genetic diversity) for the affected PS steelhead DIPs. Therefore, the proposed action would not appreciably reduce the likelihood of survival and recovery of this listed species.

2.7.2 Critical Habitat

Critical habitat was designated for PS Chinook salmon to ensure that specific areas with PBFs that are essential to the conservation of that listed species are appropriately managed or protected. The critical habitat for PS Chinook salmon will be affected over time by cumulative effects, some positive – as restoration efforts and regulatory revisions increase habitat protections and restoration, and some negative – as climate change and unregulated or difficult to regulate sources of environmental degradation persist or increase. Overall, to the degree that trends are negative, the effects on the PBFs of critical habitat for PS Chinook salmon are also likely to be negative. In this context we consider how the proposed action's impacts on the attributes of the action area's PBFs would affect the designated critical habitat's ability to support the conservation of PS Chinook salmon as a whole.

Past and ongoing land and water use practices have degraded salmonid critical habitat throughout the Puget Sound basin. Hydropower and water management activities have reduced or eliminated access to significant portions of historic spawning habitat. Timber harvests, agriculture, industry, urbanization, shoreline development, and point and non-point stormwater and wastewater discharges have adversely altered floodplain and stream morphology in many watersheds, diminished the availability and quality of estuarine and nearshore marine habitats, and reduced water quality across the region.

Global climate change is expected to increase in-stream water temperatures and alter stream flows, possibly exacerbating impacts on baseline conditions in freshwater habitats across the region. Rising sea levels are expected to increase coastal erosion and alter the composition of nearshore habitats, which could further reduce the availability and quality of estuarine habitats. Increased ocean acidification may also reduce the quality of estuarine habitats.

In the future, non-federal land and water use practices and climate change are likely to increase. The intensity of those influences on salmonid critical habitat is uncertain, as is the degree to which those impacts may be tempered by adoption of more environmentally acceptable land use practices, by the implementation of non-federal plans that are intended to benefit salmonids, and by efforts to address the effects of climate change.

The PBF for PS Chinook salmon critical habitat in the action area is limited to freshwater migration corridors free of obstruction and excessive predation. The site attributes of that PBF that would be affected by the action are freedom from obstruction and excessive predation, water quality, and natural cover. As described in the environmental baseline section, the project site is located along a heavily impacted waterway, and all three of these site attributes currently function at reduced levels as compared to undisturbed freshwater migratory corridors. As described in the effects section, the proposed action would cause minor long-term adverse effects on the identified site attributes. On the positive side, the proposed work would remove creosote-treated piles, and increase light penetration under the replacement pier.

Based on the best available information, the scale of the proposed action’s effects, when considered in combination with the degraded baseline, cumulative effects, and the impacts of climate change, would be too small to cause any detectable long-term negative changes in the quality or functionality of the freshwater migration corridors PBF in the action area. Therefore, this critical habitat will maintain its current level of functionality, and retain its current ability for PBFs to become functionally established, to serve the intended conservation role for PS Chinook salmon.

2.8 Conclusion

After reviewing and analyzing the current status of the listed species and critical habitat, the environmental baseline within the action area, the effects of the proposed action, the effects of other activities caused by the proposed action, and cumulative effects, it is the NMFS’ biological opinion that the proposed action is not likely to jeopardize the continued existence of PS Chinook salmon and PS steelhead, nor is it likely to destroy or adversely modify designated critical habitat for PS Chinook salmon.

2.9 Incidental Take Statement

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

2.9.1 Amount or Extent of Take

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

Harm of PS Chinook salmon from exposure to:

- Work- and Structure-related Noise;
- Work- and Structure-related Pollutants;
- Work- and Structure-related Propeller Wash;
- Structure-related Altered Lighting; and
- Work- and Structure-related Forage Diminishment.

Harm of PS steelhead from exposure to:

- Structure-related Noise;
- Structure-related Pollutants;
- Structure-related Propeller Wash;
- Structure-related Altered Lighting; and
- Work- and Structure-related Forage Diminishment.

The NMFS cannot predict with meaningful accuracy the number of PS Chinook salmon and PS steelhead that are reasonably certain to be injured or killed annually by exposure to any of these stressors. The distribution and abundance of the fish that occur within an action area are affected by habitat quality, competition, predation, and the interaction of processes that influence genetic, population, and environmental characteristics. These biotic and environmental processes interact in ways that may be random or directional, and may operate across far broader temporal and spatial scales than are affected by the proposed action. Thus, the distribution and abundance of fish within the action area cannot be attributed entirely to habitat conditions, nor can the NMFS precisely predict the number of fish that are reasonably certain to be injured or killed if their habitat is modified or degraded by the proposed action. Additionally, the NMFS knows of no device or practicable technique that would yield reliable counts of individuals that may experience these impacts. In such circumstances, the NMFS uses the causal link established between the activity and the likely extent and duration of changes in habitat conditions to describe the extent of take as a numerical level of habitat disturbance. The most appropriate surrogates for take are action-related parameters that are directly related to the magnitude of the expected take.

The timing of in-water work is applicable for all work-related impacts because the proposed July 16 through April 30 in-water work window avoids the period of time when juvenile Chinook salmon would be most numerous and vulnerable to the effects of the planned in-water work. Therefore, working outside of the proposed work window would likely increase the number of juvenile PS Chinook salmon that would be exposed to work-related stressors.

In addition to timing of the project, pile type, size, method of installation, and duration of installation are applicable for work-related noise because the intensity of effect would be positively correlated with the loudness of the sound, which is determined by the type and size of the pile and the method of installation. Further, the number of fish that would be exposed to pile-installation noise would be positively correlated with the size of the area of acoustic effect and the number of days that the area would be ensonified. In short, as the sound levels increase, the intensity of effect and the size of the ensonified area increases, and as the size of the ensonified area increases, and or as the number of days the area is ensonified increases, the number of juvenile Chinook salmon that would be exposed to the sound would increase despite the low density and random distribution of individuals in the action area. Based on the best available information about the planned pile installation, as described in Section 2.5, the applicable ranges of effect for this project are driven by the type and size of the piles and the method of their installation, but not by the daily duration of vibratory work or the number of piles. Therefore, the daily number of piles and daily duration of vibratory pile installation are not considered measures of take for this action.

The pile removal method, the extent of the visible turbidity plumes around that work, and the duration of extraction are the best available surrogates for the extent of take of juvenile PS Chinook salmon from exposure to work-related pollutants. The method of removal is appropriate because in-water pollutant concentrations would be positively correlated with the amount of contaminated sediments that would be mobilized in the water, which would be positively correlated with the extraction method. The proposed pulling or vibratory extraction of piles within full-depth sediment curtains would minimize sediment mobilization and lateral movement compared to other methods such as the use of excavators or water-jetting. The lateral extent of visible turbidity plumes around pile extraction is appropriate because the size the affected areas would be positively correlated with the extent of the plume. The duration of extraction work is appropriate because the number of exposed fish would be positively correlated with the length of time pollutants are mobilized in the water. Any increase in the pollutant concentrations would likely increase the intensity of effect from exposure, and any increase in the size of the affected area and or duration of mobilized pollutants could increase the number of exposed fish.

The location, size, and configuration of the replacement over-water structures are the best available surrogates for the extent of take of juvenile PS Chinook salmon and juvenile PS steelhead from exposure to structure-related noise, pollutants, propeller wash, and altered lighting. Location is appropriate because installation of the mooring floats closer to shore would increase the likelihood of exposing juvenile Chinook salmon and steelhead to vessel noise, pollutants, propeller wash, and the most intense lighting alteration, due to the increased proximity of those structures to preferred juvenile Chinook salmon habitat. Installation of the structures in shallower water would also increase propeller wash impacts on SAV and other benthic resources, which would increase the likelihood that juvenile PS Chinook salmon and juvenile PS steelhead would be experience unanticipated take due to reduced availability of shelter and forage resources.

The size of the replacement over-water structures is appropriate for structure-related noise, pollutants, and propeller wash because those stressors are all positively correlated with the number of boats that moor at a structure, which is largely a function of the structure's size. As the size of a mooring structure increases, the number of boats that can moor there increases. As the number of boats increase, boating activity increases. As boating activity increases, the potential for, and the intensity of exposure to the related noise, pollutants, and propeller wash would also increase. The size and configuration of the replacement over-water structures is appropriate for structure-related altered lighting because, salmonid avoidance and the distance required to swim around the structures would both increase as the size and opacity of the structures increase, and any increase in the artificial illumination would increase nighttime phototaxis.

The pile removal method, the extent of the visible turbidity plumes around that work, and the location, size, and configuration of the replacement over-water structures are the best available surrogates for the extent of take of juvenile PS Chinook salmon and juvenile PS steelhead from exposure to forage diminishment. Similar to exposure to work-related pollutants, the pile removal method and the extent of the visible turbidity plumes around that work are appropriate surrogates for work-related forage diminishment because surface sediment contaminant concentrations would be positively correlated with the amount of contaminated sediments that would be mobilized during pile extraction, and the size of the affected area would be positively correlated with the visible turbidity plumes. Any increase in the pollutant concentrations of the surface sediments would likely increase the intensity of effect from exposure, and any increase in the size of the affected area would likely increase the number of exposed fish.

Similar to structure-related noise, pollutants, propeller wash, and altered lighting, location is appropriate for structure-related forage diminishment because the impacts on productivity, the likelihood of propeller scour, and the likelihood of juvenile salmonids being affected by structure-related forage diminishment would all increase with movement of the mooring floats closer to shore. The size and configuration of the replacement over-water structures is appropriate because shade-related impacts on productivity would increase with the size and opacity of the structures and the number of moored vessels. Size is also appropriate because vessel-related input of pollutants is positively correlated with the number of boats that moor at a structure, which is largely a function of the structure's size. As the number of boats increase, the size of the shaded area would increase, as would the frequency and or amount of discharged pollutants.

In summary, the extent of PS Chinook salmon and PS steelhead take for this action is defined as:

- In-water work to be completed between July 16 and April 30;
- A maximum of 14 days of vibratory pile driving to install 6 12-inch diameter, 6 24-inch diameter, and 12 30-inch diameter steel pipe piles;
- A maximum of 14 days of direct pull and or vibratory pile extraction within full-depth sediment curtains;
- Work-related turbidity plumes that could extend up to 300 feet from in-water work; and
- The location, size, and configuration of the replacement over-water structures as described in the proposed action section of this biological opinion.

Exceedance of any of the exposure limits described above would constitute an exceedance of authorized take that would trigger the need to reinitiate consultation.

Although these take surrogates could be construed as partially coextensive with the proposed action, they nevertheless function as effective re-initiation triggers. If any of these take surrogates exceed the proposal, it could still meaningfully trigger re-initiation because the USACE has authority to conduct compliance inspections and to take actions to address non-compliance, including post-construction (33 CFR 326.4).

2.9.2 Effect of the Take

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

2.9.3 Reasonable and Prudent Measures

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

The USACE shall require the applicant to:

1. Ensure the implementation of monitoring and reporting to confirm that the take exemption for the proposed action is not exceeded.

2.9.4 Terms and Conditions

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

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

    a. The USACE shall require the applicant to develop and implement plans to collect and report details about the take of listed fish. That plan shall:
        i. Require the applicant and or their contractor to maintain and submit records to verify that all take indicators are monitored and reported. Minimally, the records should include:
            1. Documentation of the timing and duration of in-water work to ensure that all in-water work is completed between July 16 and April 30;
            2. Documentation of the dates, method of pile installation, and pile type and size;
            3. Documentation of the dates and method of pile extraction;
            4. Documentation of the lateral extent of the turbidity plumes, and measures taken to maintain them within 300 feet; and
            5. Documentation of the location, size, and configuration of the replacement over-water structures to confirm that they do not exceed the locations and characteristics described in this opinion.
        ii. Require the applicant to establish procedures for the submission of the construction records and other materials to the appropriate USACE office, and to submit an electronic post-construction report to the NMFS within six months of project completion. Send the report to: projectreports.wcr@noaa.gov. Be sure to include Attn: WCRO-2021-01428 in the subject line.

2.10 Conservation Recommendations

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

1. The USACE should encourage the applicant to install a clean sand cap over the pile and debris removal areas to cover mobilized contaminated sediments.

2.11 Re-initiation of Consultation

This concludes formal consultation for the USACE's authorization of Seattle Parks and Recreation's Leschi South Marina Wave Attenuator and Public Access Facility Improvements project in Lake Washington, King County, Washington.

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

2.12 "Not Likely to Adversely Affect" Determinations

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

As described in Section 2 and below, the NMFS has concluded that the proposed action is not likely to adversely affect SR killer whales and their designated critical habitat. Detailed information about the biology, habitat, and conservation status and trends of these whales can be found in the listing regulations and critical habitat designations published in the Federal Register, as well as in the recovery plans and other sources at: https://www.fisheries.noaa.gov/species-directory/threatened-endangered, which are incorporated here by reference.

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

2.12.1 Effects on Listed Species

The effects analysis in this section relies heavily on the descriptions of the proposed action and project site conditions discussed in Sections 1.3 and 2.4, and on the analyses of effects presented in Section 2.5. As described in Section 2.5, the range of detectable action-related stressors would be limited to the waters and substrates within about 300 feet around project activities in Lake Washington.

SR killer whales

The proposed action will cause no direct effects on SR killer whales or their critical habitat because all construction and its impacts would take place in freshwater, and SR killer whales and their designated critical habitat are limited to marine waters. However, the project may indirectly affect SR killer whales through the trophic web by affecting the quantity and quality of prey available to them. We therefore analyze that potential here but conclude that the effects on SR killer whales would be insignificant for at least two reasons.

First, as described in Section 2.5, the action would annually affect an extremely low number of juvenile Chinook salmon. The project's detectable effects on fish would be limited to an area no more than 300 feet around the project site, where small subsets of each year's juvenile PS Chinook salmon cohorts from the Cedar River and North Lake Washington populations could be briefly exposed to project-related impacts during the final portion their freshwater migration lifestage, and only very small subsets of the individuals that pass through the area are likely to be detectably affected by the exposure.

The exact Chinook salmon smolt to adult ratios are not known. However, even under natural conditions, individual juvenile Chinook salmon have a very low probability of surviving to adulthood (Bradford 1995). We note that human-caused habitat degradation and other factors such as hatcheries and harvest exacerbate natural causes of low survival such as natural variability in stream and ocean conditions, predator-prey interactions, and natural climate variability (Adams 1980, Quinones et al., 2014). However, based on the best available information, the annual numbers of project-affected juveniles would be too low to influence any VSP parameters for either population, or to cause any detectable reduction in adult Chinook salmon availability to SR killer whales in marine waters.

Second, as described in Sections 1.3, 2.2, and 2.5, the only PS Chinook populations that would be affected by the project would be the two Lake Washington populations that migrate through Lake Washington, and both populations are small. Total abundance between 1980 and 2020 has fluctuated between about 600 and 1,600 spawners for the Cedar River population, and 300 and 1,500 spawners for the Sammamish River population (Ford 2022). Consequently, the two populations, combined, make up a very small portion of the adult Chinook that are available to SR killer whales in marine waters. Therefore, based on the best available information, the proposed action is not likely to adversely affect SR killer whales.

2.12.2 Effects on Critical Habitat

This assessment considers the intensity of expected effects in terms of the change they would cause in affected physical or biological features (PBFs) from their baseline conditions, and the severity of each effect, considered in terms of the time required to recover from the effect. Ephemeral effects are those that are likely to last for hours or days, short-term effects would likely to last for weeks, and long-term effects are likely to last for months, years or decades.

SR killer whale Critical Habitat: Designated critical habitat for SR killer whales includes marine waters of the Puget Sound that are at least 20 feet deep. The expected effects on SR killer whale critical habitat from completion of the proposed action, including full application of the conservation measures and BMP, would be limited to the impacts on the PBFs as described below.

1. Water quality to support growth and development
   The proposed action would cause no detectable effects on marine water quality.

2. Prey species of sufficient quantity, quality, and availability to support individual growth, reproduction, and development, as well as overall population growth
   The proposed actions would cause long-term undetectable effects on prey availability and quality. Action-related impacts would annually injure or kill extremely low numbers of

individual juvenile Chinook salmon (primary prey), during the final portion their freshwater migration lifestage. However, the numbers of affected juvenile Chinook salmon would be too small to cause detectable effects on the numbers of available adult Chinook salmon in marine waters. Therefore, it would cause no detectable reduction in prey availability and quality.

3. Passage conditions to allow for migration, resting, and foraging
   The proposed action would cause no detectable effects on passage conditions.

For the reasons expressed immediately above, the NMFS has concluded that the proposed action is not likely to adversely affect ESA-listed SR killer whales and their designated critical habitat.

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

Section 305(b) of the MSA directs Federal agencies to consult with the NMFS on all actions or proposed actions that may adversely affect Essential Fish Habitat (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 the 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 the descriptions of EFH contained in the fishery management plan for Pacific Coast salmon developed by the Pacific Fishery Management Council and approved by the Secretary of Commerce (PFMC 2014).

3.1 Essential Fish Habitat Affected By the Project

The project site is located along the west bank of Lake Washington (Figure 1). The waters and substrate of Lake Washington are designated as freshwater EFH for various life-history stages of Pacific Coast Salmon, which within the Lake Washington watershed include Chinook and coho salmon. Due to trophic links between PS Chinook salmon and SR killer whales, the project's action area also overlaps with marine waters that have been designated, under the MSA, as EFH for Pacific Coast Salmon, Pacific Coast Groundfish, and Coastal Pelagic Species. However, the action would cause no detectable effects on any components of marine EFH. Therefore, the action's effects on EFH would be limited to impacts on freshwater EFH for Pacific Coast Salmon, and it would not adversely affect marine EFH for Pacific Coast Salmon, or EFH for Pacific Coast groundfish and coastal pelagic species.

Freshwater EFH for Pacific salmon is identified and described in Appendix A to the Pacific Coast salmon fishery management plan, and consists of four major components: (1) spawning and incubation; (2) juvenile rearing; (3) juvenile migration corridors; and (4) adult migration corridors and holding habitat.

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

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

3.2 Adverse Effects on Essential Fish Habitat

The ESA portion of this document (Sections 1 and 2) describes the proposed action and its adverse effects on ESA-listed species and critical habitats, and is relevant to the effects on EFH for Pacific Coast Salmon. Based on the analysis of effects presented in Section 2.5 the proposed action will cause minor short- and long-term adverse effects on freshwater EFH for Pacific Coast Salmon as summarized below.

<u>Freshwater EFH for Pacific Coast Salmon</u>

1. <u>Water quality:</u> The proposed action would cause minor short- and long-term adverse and beneficial effects on this attribute. Demolition and construction would cause short-term adverse effects on water quality that would be mostly contained within full-depth sediment curtains, and would persist no more than a low number of hours after work stops. Also, vessel moorage at the replacement structures would include persistent low-level inputs of pollutants. Conversely, the permanent removal of 52 creosote-treated timber piles would reduce ongoing PAH contamination at the site, and the removal of sunken debris is likely to reduce the presence of some toxic materials that are likely leaching into the water. Detectable water quality impacts are expected to be limited to the area within 300 feet around the project site. The action would cause no measurable changes in water temperature or salinity.

2. <u>Water quantity, depth, and velocity:</u> No changes expected.

3. <u>Riparian-stream-marine energy exchanges:</u> No changes expected.

4. Channel gradient and stability: No changes expected.

5. Prey availability: The proposed action would cause long-term minor adverse effects on this attribute. Despite the increase light penetration under the replacement access and mooring pier, the pier, the wave attenuator, and moored vessels would still cast over-water shade that would limit SAV growth and reduce the density and diversity of the benthic and planktonic communities under the replacement structures that are important prey resources for juvenile salmonids. Additionally, any contaminants that are mobilized during pile extraction, combined with low-level input of contaminants from moored recreational vessels would contaminate some of the available prey and or slightly diminish the number, size, and diversity of prey organisms available at the project site. Detectable effects would be limited to the area within about 300 feet around the replacement structures.

6. Cover and habitat complexity: The proposed action would cause minor long-term adverse effects, and minor long-term beneficial effects on this attribute. Work-related tugboat propeller scour is likely to slightly reduce SAV availability at the project site, which could take more than a year to recover. Additionally, the shade from the replacement structures would perpetuate conditions that act to limit the growth of SAV. However, compared to the existing conditions, the project would increase light penetration at the site by reducing the size of the pier and by transitioning from solid-plank decking to fully-grated decking, and by installing the solid-decked wave attenuator over 40-foot+ deep water, more than 300 feet from shore. The removal of sunken debris is likely to reduce predator-supportive artificial features within the marina, and it may slightly improve the affected area's ability to support native SAV.

7. Space: No changes expected.

8. Habitat connectivity from headwaters to the ocean: No changes expected.

9. Groundwater-stream interactions: No changes expected.

10. Substrate composition: No changes expected.

Habitat Areas of Particular Concern (HAPCs)

The project area provides no known HAPC habitat features.

3.3 Essential Fish Habitat Conservation Recommendations

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

The proposed project includes design features that reduce the planned structures' impacts on the quantity and quality of Pacific Coast salmon EFH. It also includes a comprehensive set of BMPs to minimize construction-related effects. The NMFS knows of no other reasonable measures that the applicant could include to further reduce the project's effects on the attributes of Water

Quality and Cover and Habitat Complexity. However, to reduce the action's impacts on the Prey Availability attribute:

1. The USACE should encourage the applicant to install a clean sand cap over the pile and debris removal areas to cover mobilized contaminated sediments.

3.4 Statutory Response Requirement

As required by section 305(b)(4)(B) of the MSA, the USACE must provide a detailed written response to the 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 the NMFS' EFH Conservation Recommendations unless the 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 the 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, the 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 the 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 the NMFS' EFH Conservation Recommendations [50 CFR 600.920(l)].

4. DATA QUALITY ACT DOCUMENTATION AND PRE-DISSEMINATION REVIEW

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

4.1 Utility

Utility principally refers to ensuring that the information contained in this consultation is helpful, serviceable, and beneficial to the intended users. The intended user of this opinion the USACE. Other interested users could include the applicant, the WDFW, the governments and citizens of

King County and the City of Seattle, and Native American tribes. 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 the NMFS in accordance with relevant information technology security policies and standards set out in Appendix III, 'Security of Automated Information Resources,' Office of Management and Budget Circular A-130; the Computer Security Act; and the Government Information Security Reform Act.

4.3 Objectivity

Information Product Category: Natural Resource Plan

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

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

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

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

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