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-2023-02748

November 15, 2024

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 the Douglas Lee Bulkhead Replacement, King County, Washington (USACE No. NWS-2023-00083, HUC: 171100120400 – Lake Washington).

Dear Mr. Tillinger:

Thank you for your letter of October 30, 2023, 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 USACE's authorization of the Douglas Lee Bulkhead Replacement project on Lake Washington. Thank you also for your request for essential fish habitat (EFH) consultation. The NMFS reviewed the proposed action for potential effects on EFH pursuant to section 305(b) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA), implementing regulations at 50 CFR 600.920, and agency guidance for use of the ESA consultation process to complete EFH consultation.

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 conclude 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, 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 request that in your statutory reply to the EFH portion of this consultation you clearly identify the number of conservation recommendations accepted.

Please contact Lauren Liuzza in the North Puget Sound Branch of the Oregon Washington Coastal Office at (301) 427-7878 or by electronic mail at lauren.liuzza@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: Shane Shelburne, 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

Douglas Lee Bulkhead Replacement
King County, Washington
(USACE No. NWS-2023-00083: HUC: 171100120400 - Lake Washington)

NMFS Consultation Number: WCRO-2023-02748

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: November 15, 2024

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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
EFH – Essential Fish Habitat
ESA – Endangered Species Act
ESU – Evolutionarily Significant Unit
FR – Federal Register
FMP – Fishery Management Plan
HUC – Hydrological Unit Code
HPA – Hydraulic Project Approval
HZ - Hertz
ITS – Incidental Take Statement
JARPA – Joint Aquatic Resource Permit Application
MPG – Major Population Group
MSA – Magnuson-Stevens Fishery Conservation and Management Act
mg/L - milligrams per liter
NMFS – National Marine Fisheries Service
NTU - Nephlometric Turbidity Units
NOAA – National Oceanic and Atmospheric Administration
PAH - Polycyclic Aromatic Hydrocarbons
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
PTS – Permanent Threshold Shift
RPA – Reasonable and Prudent Alternative
RPM – Reasonable and Prudent Measure
SAV – Submerged Aquatic Vegetation
SEL – Sound Exposure Level
SL – Source Level
SR – Southern Resident (Killer Whales)
TTS – Temporary Threshold Shift
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.

Updates to the regulations governing interagency consultation (50 CFR part 402) were effective on May 6, 2024 (89 Fed. Reg. 24268). We are applying the updated regulations to this consultation. The 2024 regulatory changes, like those from 2019, were intended to improve and clarify the consultation process, and, with one exception from 2024 (offsetting reasonable and prudent measures), were not intended to result in changes to the Services' existing practice in implementing section 7(a)(2) of the Act. 89 Fed. Reg. at 24268; 84 Fed. Reg. at 45015. We have considered the prior rules and affirm that the substantive analysis and conclusions articulated in this biological opinion and incidental take statement would not have been any different under the 2019 regulations or pre-2019 regulations.

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 October 30, 2023 the NMFS received a letter from the U.S. Army Corps of Engineers (USACE) to request formal consultation for their authorization of the Douglas Lee Bulkhead Replacement project (USACE 2023). The request included the applicant's Biological Evaluation (BE; NEC 2022) and Joint Aquatic Resource Permit Application (JARPA; Lee 2022), along with a project description and construction sequence and project drawings, (Waterfront 2022; Waterfront 2023).

On June 14, 2024 the NMFS requested additional information to clarify the project description. On July 18, 2024, the USACE provided the requested information via electronic mail (email) (USACE 2024b). On July 22, 2024, the NMFS requested a copy of the project's Hydraulic

Project Approval (HPA). The applicant's agent provided a copy of the HPA the same day (WDFW 2023). The NMFS considers that formal ESA consultation and EFH consultation was initiated for the proposed action on July 22, 2024.

This opinion is based on the information in the documents and other additional information identified above; 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 applicant to replace an existing bulkhead, and repair a pier on residential property on the northwest shoreline of Lake Washington in Lake Forest Park, Washington (Figure 1).

Figure 1. Google Earth images of the project site on the northwest shore of Lake Washington, in Lake Forest Park, Washington. In the left image, the yellow marker shows the project site in relation to Puget Sound and Lake Washington. In the right image, the yellow marker shows a close up view of the project site.

<u>Project Overview</u>

The proposed project would remove a 111-linear-foot soldier pile timber bulkhead, and replace it with a steel H-beam and steel sheet bulkhead within the existing bulkhead's footprint. It would also repair 16 pier-supporting piles, remove 1 derelict pile, remove about 15 square feet of rock debris, and install 30 cubic yards of gravel around the base of the new bulkhead (Figure 2).

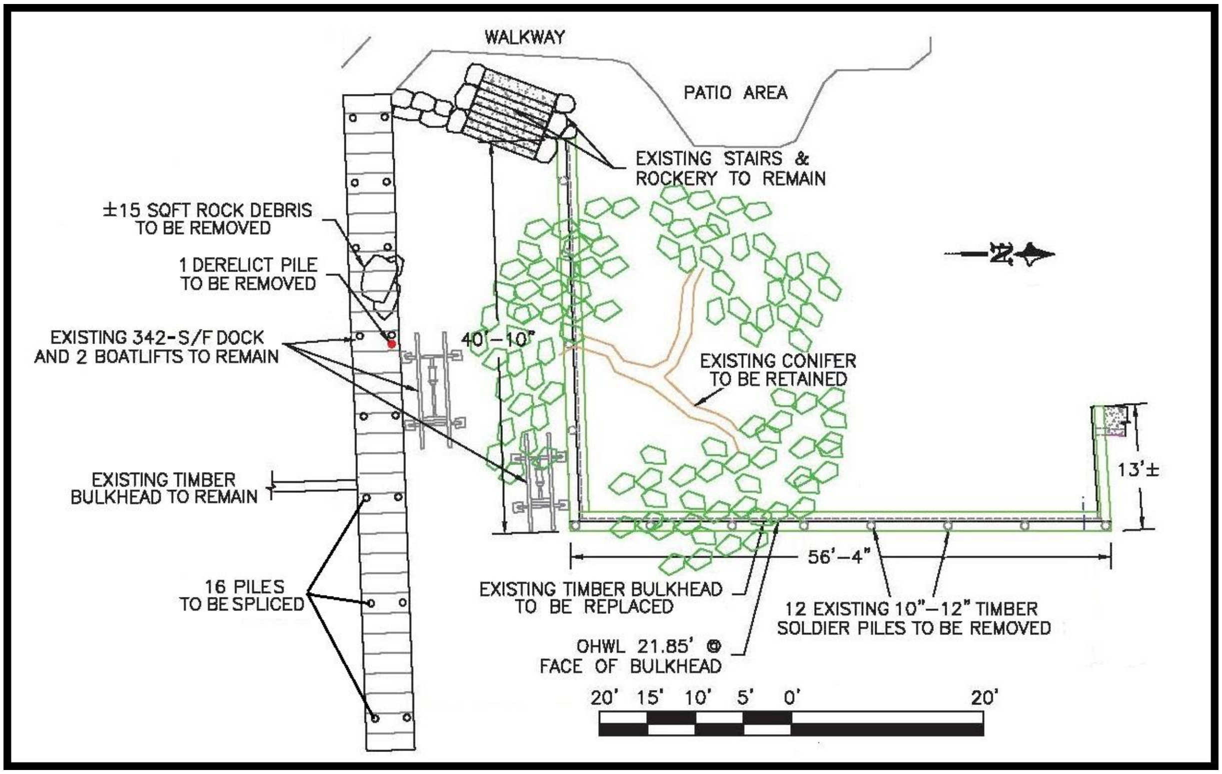

Figure 2. Overhead drawing of the project site, showing the existing conditions, and identifying the main components of the project. The image is rotated 90 degrees to better fit on the page (Adapted from sheet 3 of 17 in Waterfront 2023).

The project would require about 20 days of construction that would be done during both the in-water work windows for the project area; July 16 through July 31 and November 16 through December 31. Most project related work, and all project staging and debris collection would be conducted from a construction barge. Some work is also likely to be done from the pier and or small workboats, as well as by divers working under the pier.

The applicant’s contractor would be required to comply with the best management practices (BMPs) and conservation measures identified in the BE as well as the provisions of the Hydraulic Project Approval (HPA) for the project (WDFW 2023) during this work. These include, but are not limited to, the installation of a full-depth sediment curtain around the barge and bulkhead during replacement of the bulkhead, the installation of a floating debris boom around the pier during pile splicing, and measures to reduce the potential for discharge of toxic material to lake waters. All construction debris would be loaded onto the construction barge and transported to the contractor’s Seattle yard, off-loaded, and shipped to an approved upland disposal site.

Bulkhead Replacement

Before bulkhead demolition or construction begin, the construction crew would install a full-depth sediment curtain around the barge and bulkhead (Figure 3). They would use barge-mounted hoisting equipment such an excavator or backhoe to remove the existing bulkhead. This would include some excavation behind the bulkhead, the extraction of the existing 12 10- to 12-inch diameter timber soldier piles, by pulling, and the removal of the timber bulkhead wall planks. All removed material would be placed on the barge for upland disposal. Excavated material would be stockpiled on the lawn for use as backfill material behind the new bulkhead.

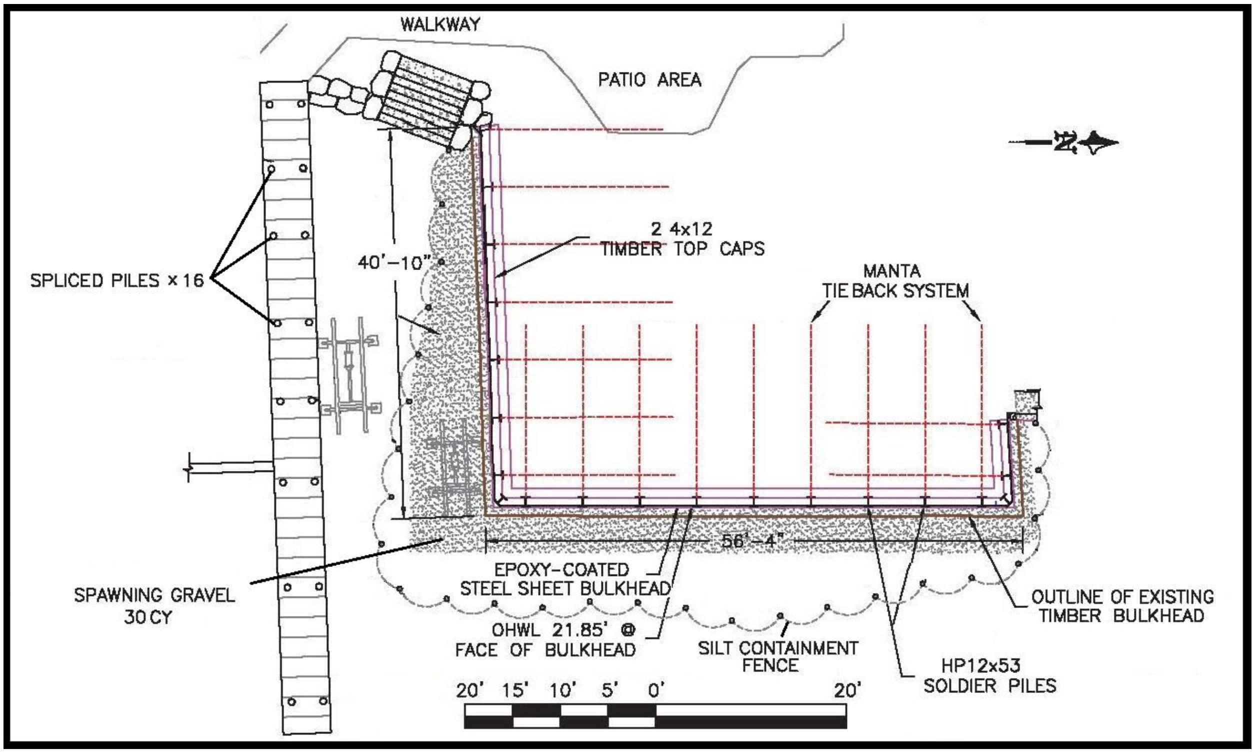

Figure 3. Overhead drawing of the project site, showing the proposed conditions of the project. The image is rotated 90 degrees to better fit on the page (Adapted from Sheet 3 of 17 in Waterfront 2023).

They would use the barge-mounted excavator or backhoe with a vibratory pile driver to install 20 12-inch, epoxy coated steel H-beams. The applicant's agent estimates that 3 days would be required for this work, with up to 120 minutes of vibratory driving per day. After the H-beams are installed, they would affix quarter-inch thick epoxy-coated steel sheets by bolting the sheets to the H-beams. A filter fabric will be installed to stop any particles from escaping through the bulkhead. They would use the excavator or backhoe with a vibratory or a concrete breaking hammer to install about 14 Manta Ray anchors into the lawn behind the bulkhead to hold the bulkhead in place. The exact timing and duration of the Manta Ray driving work is unknown. Previously excavated material will be stored on site and used as backfill behind the new bulkhead.

After bulkhead construction is complete, the construction crew would use the barge-mounted excavator or backhoe to install 30 cubic yards of spawning gravel around the base of the new bulkhead. The material will be bagged in 1-yard sacks, hanging by a crane or backhoe at the location site. The construction crew will cut the bottom of the bag allowing for the gravel to be deposited on site.

Pier Repair

Before pier repair work begins, the construction crew would install a floating debris boom around the pier. Working from the barge, small work boats, and the pier, the construction crew and divers would repair 16 of the 17 existing 10- to 12-inch diameter timber piles that support the applicant's existing pier. They would also remove the 17^{th} pile and about 15 square feet of rock debris from under the pier. The exact timing and duration of the pier work is unknown.

Using underwater saws, the divers would cut off the damaged upper portions of 16 timber piles. The construction crew would use the barge-mounted excavator or backhoe to hoist the cut-off pile ends aboard the barge for upland disposal. The construction crew and or divers would install epoxy-coated steel bonnet splices onto the 16 pile stubs, and attach those splices to the pier's existing pile caps. The construction crew and divers would use the barge-mounted excavator or backhoe to hoist about 15 square feet of rock debris aboard the barge for upland disposal.

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 pier. Based on the pier's location and size, the NMFS assumes that 1 to 2 mid-sized motorized vessels would moor alongside the pier. Therefore, the action would facilitate the continued mooring and operation of 1 to 2 vessels per day at the pier for decades to come. Consequently, we have included an analysis of the effects of that vessel operation and the 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 likely to adversely affect PS Chinook salmon, PS steelhead, and designated critical habitat for PS Chinook salmon. They further determined that the proposed action may affect, but is not likely to adversely affect Southern Resident (SR) killer whales. The USACE also determined the proposed action would have no effect on any other species and or critical habitats under NMFS jurisdiction. 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, and has proceeded with formal consultation. Our concurrence with the USACE'S NLAA determination for SR killer whales can be found in section 2.12, where we analyzed the action's potential effects on SR killer whales and their designated critical habitat, and concluded that the proposed action may affect, but is not likely to adversely affect ESA-listed SR killer whales and their designated critical habitat (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 designated critical habitat, evaluates the conservation value of the various watersheds and coastal and marine environments that make up the designated critical habitat, and discusses the function of the PBFs that are essential for the species' conservation.

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 meta-populations (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.

<u>Puget Sound (PS) Chinook Salmon</u>

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).

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

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

PS Chinook Salmon within the Action Area: 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 2024a). 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 2024b). 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 2024b). 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 traveling through the lake. 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).

Puget Sound (PS) Steelhead

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 the NMFS in 2016 (81 FR 9251, February 24, 2016). The NMFS adopted the steelhead recovery plan for the Puget Sound DPS in December, 2019.

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

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.

General Life History: 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, (two years is typical) prior to migrating to marine habitats. 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, (most commonly two years), 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).

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 2024a). 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 returned annually since 2007. The estimated total number of returning adults in 2021 was only 4 fish (WDFW 2024c).

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 out at no more than 10 retuning adults. Abundance was only 4 adults during the last survey, which was done in 1999 (Ford 2022; WDFW 2024c).

Adult and juvenile steelhead salmon primarily use the project site for freshwater migration, with juveniles also likely foraging while traveling through the lake. 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 (City of 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 (City of 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.

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

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 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, diversity, 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).

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 head-gates 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. Additionally, 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 2024; WDFW 2024a).

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 Lake Forest Park, Washington, along the northwestern shore of Lake Washington, about 9.4 miles north of the Highway 520 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 and around pile removal work and barge 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 process. The impacts 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).

Climate Change

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, inter-annual 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.

<u>Marine and Estuarine Environments</u>: 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).

Climate change effects on salmon and steelhead: In freshwater, year-round increases in stream temperature and changes in flow will affect physiological, behavioral, and demographic processes in salmon, and change the species with which they interact. For example, as stream temperatures increase, many native salmonids face increased competition with more warm-water tolerant invasive species. Changing freshwater temperatures are likely to affect incubation and emergence timing for eggs, and in locations where the greatest warming occurs may affect egg survival, although several factors impact 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 Lake Forest Park, Washington, along the northwestern shore of Lake Washington, about 9.4 miles north of the Highway 520 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 and 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 project area have been dramatically altered by human activity since European settlers first arrived in the 1800s. Heavy timber harvests from the 1870s through the early twentieth century removed almost all of the area's forests. Additionally, the watershed historically drained out of the south end of Lake Washington, to the Duwamish River via the now absent Black River instead of through the Lake Washington Ship Canal as it does now. Dredging and excavation of what is now the ship canal was started in the 1880s to create a navigable passage between Lake Washington and the marine waters of Puget Sound. 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 Lake Washington by about nine feet, and stopped flows through the Black River. Completion of the Lake Washington Ship Canal also lowered the water level in Lake Sammamish and dried the marshes along the Sammamish River (WRIA 8 2005). Between 1962 and 1964, the USACE dredging channelized the Sammamish River into its current configuration, which deepened the river by five feet, hardened its banks, and dramatically reduced floodplain connectivity along most of its length (Martz et al. 1999).

Development since the 1800s has converted most of the lowland areas of the watershed to urban, agricultural, and industrial uses, and forestry and agricultural practices continue to impact the upper portions of the watershed (WRIA 8 2005). Over half of the lowland area adjacent to these waterways is now considered fully developed (King County 2016). Urban development has converted most of the original 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. Additionally, the majority of the shoreline areas have been armored by bulkheads and rip rap, and thousands of piers and docks have been installed (Toft 2001).

Within the ship canal, water flows are highly controlled by the locks, and are typically very slow. The canal supports high levels of commercial and recreational vessel traffic. Very little natural shoreline exists along the banks of the ship canal. About 96% of the canal's banks are armored with vertical slopes along most of its length (City of Seattle 2008). The depths along the edges are typically between 10 and 20 feet, and the average depth in the navigational channel is about 30 feet.

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).

Water quality has been impacted across the watershed by point and nonpoint pollution sources including past sewage discharges. Ongoing sources include stormwater discharges and subsurface flows containing pollutants from roadways, failing septic systems, underground petroleum storage tanks, 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 lakes is generally considered good (City of Seattle 2010). Also, since 1979, water temperatures in the ship canal have increased an average of 1° Celsius (C) per decade, with temperatures that can reach 20 to 22° C during the summer and early fall, and the number of days that temperatures are in that range is increasing (City of Seattle 2010). Temperatures of 23 to 25° C can be lethal for salmon. Saltwater intrusion through the locks creates a wedge of high-density saltwater that can extend into and past Lake Union during low flow periods, and often becomes anoxic early in the summer as bacteria consume organics in the sediment. Dissolved oxygen concentrations range from 9.5 to 12.6 mg/L during the winter and spring, but can decrease to as low as 1 mg/L during the summer months.

The water quality northeast of the project site is categorized by the State's Department of Ecology (WDOE) as a Category 1 waterbody for Ammonia-N and Category 5 for temperature (WDOE 2024).

The past and ongoing anthropogenic impacts described above have impacted PS Chinook salmon and PS steelhead, as well as the attributes of critical habitat downstream of the project site from Lake Washington to the Chittenden Locks. However, adults and juveniles of both species continue to migrate through the affected 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 but that are not part of the action. A consequence is caused by the proposed action if it would not occur but for the proposed action and it is reasonably certain to occur. Effects of the action may occur later in time and may include consequences occurring outside the immediate area involved in the action (see 50 CFR 402.02).

As described in Section 1.3, the USACE would authorize the applicant to replace a 111-linear foot residential bulkhead, repair 16 piles under their existing pier, and remove one derelict pile and concrete debris. Work would primarily be done from a construction barge, and is expected to require a single work season to complete, consisting of both in-water work windows for the project area. (July 16 through July 31 and November 16 through December 31).

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 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, the new bulkhead would maintain suboptimal shoreline conditions and forage diminishment. The repaired pier 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 windows avoid virtually all of the normal emigration season for juvenile PS Chinook salmon, but the July window overlaps with the normal migration season for returning adults, which can be expected in Lake Washington mid-June through the end of October. The work windows also overlap with the normal migration seasons for 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 bulkhead and the repaired pier, 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 habitat impacts. 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

Work-related noise is not likely to adversely affect any individuals of either species considered in this opinion. However, exposure to structure-related (post-construction) noise is likely to adversely affect juvenile PS Chinook salmon, but cause only minor effects in adults of both species and in juvenile PS steelhead.

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 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 6 weeks of project-related work, and vessel operation at the project site. The proposed project would include a mix of in-and above-water work that would include the use of vibratory pile extraction/installation equipment, a construction barge and various hand-held power tools. Of these, barge spuds and the pile extraction/installation work would be the loudest sources, followed by the barge and handheld power tools. Additionally, over its extended life, the repaired pier is expected to support the moorage and operation of one to two powerboats.

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 any of the project's work-related noise could be present around the affected structures and vessels anytime during the estimated 6 weeks of project work.

The estimated source levels (SL, sound level at 1 meter from the source) and acoustic signature information used in this assessment are based on the best available information, as described in acoustic assessments for similar projects (NMFS 2017; 2018), and in other sources (Blackwell and Greene 2006; CalTrans 2015; 2020; CDC 2007; FHWA 2017; McKenna et al. 2012; Picciulin et al. 2010; Reine et al. 2012; 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 impulsive noise levels at or above the 206 dB_{peak} threshold for instantaneous injury would not occur under the proposed action. 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 207 feet (63 m) around vibratory driving of 12-inch H-beams, 177 feet (54 m) around spud deployments, 72 feet (22 m) around tugboat operations, manta anchor driving, and vibratory extraction of 14-inch timber piles, 62 feet (19 m) around driving manta anchors, and 33 feet (10 m) during power tool use and 23 foot powerboat operations (Table 5).

Table 5. Estimated in-water source levels for the loudest project-related sound sources, and the source-specific ranges to the applicable effect thresholds for fish.

Source	Acoustic Signature	Source Level	Threshold Range
Spuds	< 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 dB_{SEL} @ 54 m
Vibrate 12-inch Steel H-beams	< 2.5 kHz Non-Impulsive	190 dB_{peak}	206 dB_{peak} @ 1 m
2 days of 180 minutes of work per day.		177 dB_{SEL}	187 SEL_{CUM} @ N/A
		177 dB_{SEL}	150 dB_{SEL} @ 63 m
Jackhammer	Est. < 2 kHz Impulsive	189 dB_{peak}	206 dB_{peak} @ N/A
Best analog for driving manta anchors. Assumed daily maximum of 4 hours (14,400 seconds) over the life of the project.		169 dB_{SEL}	187 SEL_{CUM} @ 8 m
		169 dB_{SEL}	150 dB_{SEL} @ 19 m
Tugboat	< 2 kHz Combination	185 dB_{peak}	206 dB_{peak} @ N/A
Episodic periods, with an assumed daily maximum of 2 hours (720 seconds) over the life of the project.		170 dB_{SEL}	187 SEL_{CUM} @ 6 m
		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
Episodic periods, with an assumed daily maximum of 4 hours (14,400 seconds) over the life of the project.		165 dB_{SEL}	187 SEL_{CUM} @ 4 m
		165 dB_{SEL}	150 dB_{SEL} @ 10 m
Dredge Bucket Strike	< 370 Hz Impulsive	184 dB_{peak}	206 dB_{peak} @ N/A
Best analog for excavation and fill. Assumed daily maximum of 4 hours (14,400 seconds) over the life of the project.		167 dB_{SEL}	187 SEL_{CUM} @ N/A
		167 dB_{SEL}	150 @ 14 m
Vibrate 14-inch Timber piles	< 2.5 kHz Non-Impulsive	180 dB_{peak}	206 dB_{peak} @ N/A
Estimated 7 days of 80 minutes of work per day.		170 dB_{SEL}	187 SEL_{CUM} @ N/A
		170 dB_{SEL}	150 dB_{SEL} @ 22 m
23-foot Boat w/ 2 4~ 100 HP Engines.	< 2 kHz Combination	175 dB_{peak}	206 dB_{peak} @ N/A
Best analog for boats likely to moor at the repaired dock. Episodic periods measured in minutes to hours.		165 dB_{SEL}	187 SEL_{CUM} @ N/A
		165 dB_{SEL}	150 dB_{SEL} @ 10 m

Work-related Noise Effects: Based on the duration and timing of the proposed in-water work, relative to the emigration season for juvenile PS Chinook salmon, and the rarity of PS steelhead in the watershed, it is extremely unlikely that any juvenile PS Chinook salmon and or PS steelhead of any life stage would be exposed to the direct effects of the action-related work. However, the July work window overlaps with the immigration season for returning adult Chinook salmon in Lake Washington.

Because the exact timing of the various work components and how they might overlap with the presence of adult Chinook salmon in uncertain, and to avoid underestimating impacts, this assessment assumes that at any time between July 16 and 31, a mix of impulsive and non-impulsive work-related in-water noise levels above 150 dB_{SEL} would be continuously present within 33 feet (10 m) around all of the project-affected structures, tugboats/workboats, and barges during the daylight work hours, and that the 150-dB_{SEL} isopleth would extend to between 72 and 207 feet around the work area during tugboat operations, manta anchor installation, pile extraction, spud deployments, and pile installation.

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 area long enough to experience any fitness impacts. Because of their independence of shoreline habitats, exposed individuals would, at most, detect the noise, and avoid the ensonified areas. 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.

Structure-Related Noise Effects: Because structure-related vessel operations could occur at any time of the year, and over several decades after the pier repair, this assessment assumes that juvenile and adults of both species considered here are likely to be exposed to the noise from structure-related vessel operations.

This assessment uses vessel noise information for a 23-foot long power boat running at full power as a surrogate for the vessels likely to utilize the repaired pier (Table 5). We recognize that it is extremely unlikely that vessels would be run at full speed while near the repaired pier. However, vessel operators do often briefly use high power settings while maneuvering. Therefore, we believe that use of the available information would be protective of fish, without grossly overestimating potential impacts. As such, we expect that vessel-related noise levels at or above 150 dB_{SEL} are likely to routinely extend 33 feet (10 m) around the repaired pier. Based on the best available information, the expected vessel-related noise levels are extremely unlikely to cause anything more than behavior effects in exposed fish.

For the same reason expressed immediately above for work related noise effects, in adult Chinook salmon, it is extremely unlikely that exposure to vessel-related noise would cause anything more than minor behavioral responses that would have no meaningful effect on the fitness or normal behaviors of adult Chinook salmon and PS steelhead. Similarly, because the steelhead smolt that pass the area would be largely shoreline independent, they would be about equally likely to do so offshore or along the nearshore, and any avoidance of the nearshore area would be unlikely to cause any meaningful effects on their fitness or normal behaviors.

However, the juvenile Chinook salmon that would emigrate past the project site would be shoreline-obligated and compelled to stay as close to shore as possible. Juvenile Chinook salmon that are within the 150 dB_{SEL} isopleth, are likely to experience behavioral disturbances, such as acoustic masking, startle responses, altered swimming patterns, area avoidance, and increased risk of predation, and the intensity of these effects would increase with increased proximity to the source and or duration of exposure. Response to this exposure would be non-lethal in most cases, but some individuals may experience stress and fitness effects that could reduce their long-term survival, and individuals that are eaten by predators would obviously be killed. The annual numbers of juvenile PS Chinook salmon that would be exposed to this stressor are unquantifiable with any degree of certainty, and the numbers are likely to vary greatly over time. However, they would be very low. Based on the relatively small affected area, and the existence of multiple routes taken by emigrating juveniles, the PS Chinook salmon that would annually enter the affected area would be small and variable subsets of their respective populations' cohorts. Additionally, the majority of juvenile Chinook salmon would emigrate past the area between late winter and the end of spring when boating activity is typically low and sporadic. This combined with the typically episodic and short-duration of vessel operations near piers and docks, supports the expectation that the probability and duration of exposure to vessel noise would be very low for any individual fish. Therefore, the juvenile PS Chinook salmon that may be exposed to vessel-related elevated noise would represent extremely small subsets of their respective cohorts, and the annual numbers of individuals that would be meaningfully affected by this stressor would be too low to cause detectable population-level effects.

Work- and Structure-Related Pollutants

Direct exposure to work-related pollutants is not likely to adversely affect any individuals of either species considered in this opinion. Indirect exposure to structure-related pollutants is likely to adversely affect juvenile PS Chinook salmon, but cause only minor effects for adults of both species and juvenile PS steelhead. Also, indirect exposure to structure-related pollutants through the trophic web is likely to adversely affect juvenile PS Chinook salmon and juvenile PS steelhead, but cause only minor effects for adults of both species. Trophic impacts are discussed separately, below, under work- and structure-related forage diminishment.

The proposed work would temporarily affect water quality through increased turbidity and the introduction of toxic materials from equipment-related spills and discharges. Post-construction structure-related vessel operations would also 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.

The project would extract 13 10- to 12-inch diameter timber piles and remove in-water debris, which would mobilize bottom sediments. It would also install 20 12-inch, steel H-beams (H-piles). 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 pile extraction is unlikely to mobilize as much sediment as described above because the piles have much smaller surface areas for sediments to adhere to. Therefore, resulting turbidity is likely to be less intense and lower in duration than that reported by Bloch. Additionally, all bulkhead pile work would be done within full-depth sediment curtains that would reduce the spread of mobilized sediments. The sediment layers on the debris or its embeddedness into the lake bed was not described by the applicant, 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 would 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 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 few hours 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 project activities 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: Toxic materials are likely to enter the water through work-related spills and discharges from equipment and vessels, and from structure-related recreational vessel operations.

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 Polycyclic Aromatic Hydrocarbons (PAHs), Polychlorinated Biphenyls (PCBs), phlalates, other organic compounds, and metals. Additionally, anti-fouling hull paints leach copper. The new steel piles would be epoxy-coated, and therefore very unlikely to leach zinc into the water.

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 ranging 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).

Work-Related Pollutant Effects: Based on the duration and timing of the proposed in-water work, relative to the emigration season for juvenile PS Chinook salmon, and the rarity of PS steelhead in the watershed, it is extremely unlikely that any juvenile PS Chinook salmon and or PS steelhead of any life stage would be exposed to the direct effects of the action-related work. However, the July work window overlaps with the immigration season for returning adult Chinook salmon in Lake Washington.

It is uncertain how the timing of the various work components might overlap with the expected presence of adult Chinook salmon in Lake Washington. Therefore, to avoid underestimating impacts, this assessment assumes that at any time during July 16 - 31 in-water work window, adult Chinook salmon could be exposed to any of the work-related pollutant sources.

Based on the scope and scale of the proposed work, including its protective measures and BMPs, if adult Chinook salmon are present near the project site during any portion of the proposed work, it is extremely unlikely that the pollutant concentrations and or duration of exposure would be high enough to cause any detectable fitness impacts in exposed individuals. Given their independence of shoreline habitats, the most likely effect of exposure to work-related waterborne toxic materials would be temporary avoidance of the affected area, which is not expected to exceed 300 feet around the proposed work site. 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.

Structure-Related Pollutant Effects: Structure-related recreational vessel operation could occur at any time of the year, and over several decades after construction. Therefore, this assessment assumes that juvenile and adult Chinook salmon and steelhead could be exposed to the pollutants from those vessel operations. For the same reasons expressed above under work-related pollutant effects, it is extremely unlikely that adult salmonids would experience anything more than avoidance of the project area, which would cause no meaningful impacts on their fitness or normal behaviors. Similarly, because the steelhead smolt that may pass the area would be largely shoreline independent, they would be about equally likely to do so off shore or along the nearshore, and any project-related avoidance of the project area would be unlikely to cause any meaningful effects on their fitness or normal behaviors.

Conversely, the juvenile Chinook salmon that emigrate past the site would be compelled to swim close to shore, and through the project area. Again, the most likely effect of exposure to structure-related pollutants would be avoidance of the affected area. However, as described in more detail below under structure-related altered lighting, areal avoidance by juvenile Chinook salmon could cause fitness impacts and or increase their risk of predation.

As discussed above for structure-related noise, the majority of juvenile Chinook salmon would emigrate past the area between late winter and the end of spring when boating activity at the site would likely be low and sporadic, and the likelihood of exposure to vessel-related pollutants would be very small for the majority of any cohort. Additionally, pollutant-related avoidance effects are likely to be indistinguishable from those caused by the pier, and so small as to have no detectable additive effect on the total. Therefore, we don't assess potential levels of take for this stressor here, but group it in with the assessment under structure-related altered lighting.

Work- and Structure-Related Propeller Wash

Work-related propeller wash is not likely to adversely affect any individuals of either species considered in this opinion. However, exposure to post-construction structure-related propeller wash is likely to adversely affect juvenile PS Chinook salmon and PS steelhead, but cause only minor effects in adults of both species.

The proposed work would include the use of a tugboat and possibly smaller workboats operating close to shore, and after construction, powerboats would be routinely operated at and near the applicant's pier for decades to come. 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, it is extremely unlikely that any juvenile PS Chinook salmon or PS steelhead of any life stage would be exposed to work-related propeller wash, although adult Chinook salmon may be exposed. However, over the decades-long life of the repaired pier, it is reasonably likely that some adults and juveniles of both species would be exposed to structure-related propeller wash, which could occur year round.

Juvenile Chinook salmon and steelhead in the project area would be relatively small and weak, and when near the repaired pier, likely to remain close to the surface where they could be exposed to spinning propellers and powerful propeller wash. 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 encounter, 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 small 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.

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 noise and pollutants, 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 majority of juveniles would emigrate past the area between late winter and the end of spring when boating activity at the pier would likely be low and sporadic.

Therefore, the probability of exposure to propeller wash would be extremely low for any individual fish that passes through the project area, and the numbers of individuals that would be meaningfully affected by the exposure would most likely comprise very small subsets of the individuals that pass through the area. Therefore, the annual numbers of juvenile 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 tugboats, 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 shallow water close to shore. The exact number and sizes of the affected areas are uncertain, but they are expected to be relatively small compared to 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, diminished water quality, and altered lighting discussed above and below. However, the intensity of this effect would be too 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.

Structure-Related Altered Lighting

Exposure to 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 applicant’s solid-decked pier is about 68 feet long and 5 feet wide, and placed such that the first 41 feet of its western side is located directly along the shoreline (Figures 2 & 3). The repaired pier would continue to create about 340 square feet of intense unnatural daytime shade over the water and aquatic substrate, and the moored vessels would increase the size of that area. The intensity of the pier’s shadow effects 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 shade of the repaired pier and moored boats would reduce aquatic productivity, alter juvenile salmonid migratory behaviors, and increase juvenile salmonids’ exposure and vulnerability to predators as compared to unshaded similar habitat.

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 repaired pier and moored boats would be more supportive of SAV and benthic invertebrates without those structure-related 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 pier, 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, as compared to areas without over-water structures, the repaired pier's shade would maintain conditions that are likely to increase altered migratory behaviors for at least some of the juvenile Chinook salmon that pass through the project area. In some juvenile Chinook salmon, it would exacerbate the inhibition against normal shoreline obligation. The shade is likely to induce some individuals to swim around the pier, effectively increasing the time and distance they would 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 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.

In summary, over the extended life of the repaired pier, some juvenile PS Chinook salmon and steelhead would experience behavioral disturbance and or increased exposure and vulnerability to predators that would result from exposure to some combination of impacts resulting from action-related pollutants and altered lighting.

The annual numbers of those fish that would be meaningfully impacted by those exposures are unquantifiable with any degree of certainty, and the numbers are likely to vary greatly over time. However, for the same reasons expressed under noise and pollutants, 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. Additionally, the majority of juveniles would emigrate past the area between late winter and the end of spring when boating activity at the pier would likely be low and sporadic, which, supports the expectation that the probability and duration of direct exposure structure-related pollutants would be very low for any individual fish. Therefore, the juvenile PS Chinook salmon and PS steelhead that may be exposed to any combination of action-related pollutants and altered lighting would represent extremely small subsets of their respective cohorts, and the annual numbers of individuals that would be meaningfully affected by this combination of stressors would be too low to cause detectable population-level effects.

Forage Diminishment

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 meaningfully affected by 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 continued physical presence of the repaired pier and its related recreational vessel use are all likely to reduce the quality and or availability of forage organisms at the project site.

Forage Contamination:

The operation of construction equipment, tugboats, and recreational vessels frequently results in 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 the lake bed, and while present, some of those pollutants are likely to be taken up by benthic infaunal and epifaunal invertebrate organisms.

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.

Reduced Forage Availability:

In addition to forage contamination, the action-attributable in-water pollutant 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.

Propeller wash from work-related tugboat operations is likely to impact some parts of the lake bed with enough thrust to wash away (scour) SAV and benthic organisms. This would most likely cause a low number of relatively small areas where SAV and benthic organisms would be damaged or 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 pre-construction conditions, and the recovery of the affected benthic communities, especially those under and or immediately adjacent to the replacement structures could be delayed by the impacts of structure-related shade and pollutants. The shade of the repaired pier would maintain an area of reduced availability, diversity, and quality of the SAV and benthic organisms.

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 juvenile 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 small. 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 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 on this attribute. Work and structure-related in-water noise 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.
   b. Water quantity – The proposed project would cause no effect on this attribute.
   a. Water quality – The proposed action would cause minor short- and long-term adverse 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 few hours after work stops. Also, vessel moorage at the replacement structures would include persistent low-level inputs of pollutants. 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.
   c. Natural Cover – The proposed action would cause minor long-term adverse 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. The continued presence of the pier would maintain conditions that would limit SAV growth within its shaded area.

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.

<u>PS Chinook Salmon</u>

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 in Lake Forest Park, Washington, near the northwest shore 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 avoids the emigration season for juvenile PS Chinook salmon, but overlaps with the normal immigration season for returning adults. The proposed work is not expected to cause any meaningful effects. However, over the next several decades, some emigrating juveniles that pass through the project site would be exposed to structure-related altered habitat conditions, including diminished forage resources that would individually and or collectively 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 meaningfully 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.

Puget Sound Steelhead

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 the 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 returning annually since 1994.

The project site is located in Lake Forest Park, Washington, near the northwest shore 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, some emigrating juveniles that pass through the project site would be exposed to structure-related altered habitat conditions, including diminished forage resources that would individually and or collectively 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 meaningfully 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 storm water 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 the water quality site attribute is currently 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 water quality.

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

2.9.1 Amount or Extent of Take

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

Harm of juvenile PS Chinook salmon from exposure to:

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

Harm of juvenile PS steelhead from exposure to:

- Structure-related Propeller Wash;
- Structure-related Altered Lighting; and
- 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 listed fish that occur within the action area are affected by numerous biotic and environmental processes, such as timing in relation to the life stage and typical behaviors of the species under consideration, intra- and inter-specific interactions such as competition and predation, habitat quality, and the interaction of processes that influence genetic, population, and environmental characteristics. The 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. Therefore, the distribution and abundance of listed fish in any given area are likely to vary greatly, and somewhat randomly, over time.

Further, the NMFS knows of no device or practicable technique that would yield reliable counts of individuals that may be injured or killed annually by exposure to the proposed action's impacts. In such circumstances, the NMFS uses the causal link established between an activity and the likely extent and duration of changes in habitat conditions as surrogates 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.

For this action, the timing of in-water work is applicable because the proposed July 16 through July 31 and November 16 through December 31 in-water work windows avoids the expected presence of PS Chinook salmon in the project area. Therefore, working outside of the proposed work window would increase the potential that PS Chinook salmon would be exposed to work-related stressors that they would otherwise not be exposed to.

The size and configuration of the replacement bulkhead and the existing pier are the best available surrogates for the extent of take of juvenile PS Chinook and PS steelhead from exposure to structure related effects and forage diminishment. Structure size and configuration are appropriate surrogates for structure-related noise, pollutants, and propeller wash because those stressors are all positively correlated with the number and sizes of the boats that could use the existing pier, which is largely a function of the pier's size. Any increase in the number or size of the vessels that use the pier could increase the intensity of vessel-related noise, pollutants, and propeller wash impacts on juvenile salmonids. Also, increasing the size of the replacement bulkhead and the existing pier would increase the area of artificial substrate and or increase the size of the shaded substrate. This could decrease the amount of available SAV and decrease the availability and quality of forage resources at the site, which would increase the fitness impacts on juvenile salmonids at the project site.

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 through July 31 and November 16 through December 31; and
- The size and configuration of the replacement bulkhead and the existing pier 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" refer to those actions the Director considers necessary or appropriate to minimize the impact of the incidental take on the species (50 CFR 402.02).

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 July 16 through 31 and November 16 through December 31; and
            2. Documentation of the size and configuration of the replacement bulkhead and the existing pier to confirm that they do not exceed the 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-2023-02748' 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 location-appropriate native riparian vegetation along the lakeward edge of the replacement bulkhead.

2.11 Reinitiation of Consultation

This concludes formal consultation for the USACE's authorization of the Lee Bulkhead Replacement and Pier Repair 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, where discretionary federal involvement or control over the action has been retained or is authorized by law and: (1) If the amount or extent of taking specified in the incidental take statement is exceeded; (2) If new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not previously considered; (3) If the identified action is subsequently modified in a manner that causes an effect to the listed species or critical habitat that was not considered in the biological opinion or written concurrence; or (4) If a new species is listed or critical habitat designated that may be affected by the identified action."

2.12 "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.

The USACE determined that the proposed action is not likely to adversely affect southern resident (SR) killer whales, and would have no effect on their critical habitat. In this section, the NMFS analyzes the action's potential effects on SR killer whales, and because sufficient prey is an identified PBF of SR killer whale critical habitat, and the proposed action is likely to adversely affect PS Chinook salmon, which is the primary prey species for SR killer whales, we also analyze the action's impacts on SR killer whale critical habitat. Detailed information about the biology, habitat, and conservation status and trends of the SR killer 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" are all consequences to listed species or critical habitat that are caused by the proposed action, including the consequences of other activities that are caused by the proposed action. A consequence is caused by the proposed action if it would not occur but for the proposed action and it is reasonably certain to occur. Effects of the action may occur later in time and may include consequences occurring outside the immediate area involved in the action (50 CFR 402.02). When evaluating whether the proposed action is not likely to adversely affect listed species or critical habitat, the NMFS considers whether the effects are expected to be completely beneficial, insignificant, or discountable. Completely 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. Effects are considered discountable if they 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.

Southern Resident (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 Sammamish River populations could be briefly exposed to project-related impacts during their freshwater migration life stage, and only very small subsets of the individuals that pass through the area are likely to be meaningfully 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 their freshwater migration life stage. 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.

Based on this analysis, 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 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 may result from actions occurring within EFH or outside of it and may include direct, indirect, site-specific or habitat-wide impacts, including individual, cumulative, or synergistic consequences of actions (50 CFR 600.810). Section 305(b) of the MSA also requires 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 (FMP) 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 in Lake Forest Park, Washington, along the northwest 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 would cause minor short- and long-term adverse effects on freshwater EFH for Pacific Coast Salmon as summarized below.

Freshwater EFH for Pacific Coast Salmon

1. Water quality: The proposed action would cause minor short- and long-term adverse 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 repaired pier would include persistent low-level inputs of pollutants. 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. Water quantity, depth, and velocity: No changes expected.

3. Riparian-stream-marine energy exchanges: 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. 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. Additionally, the shade of the repaired pier would reduce prey quality and or availability through shade-related reduced productivity. Detectable effects would be limited to the area within about 300 feet around the repaired pier.

6. Cover and habitat complexity: The proposed action would cause minor long-term adverse 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, and the repaired pier's shade would maintain conditions that reduced SAV growth.

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 proposed project includes design features and BMPs that would reduce impacts on the quantity and quality of Pacific Coast salmon EFH. The NMFS knows of no other reasonable measures that the applicant could include to further reduce the project's effects on the Water Quality attribute. However, to reduce the action's impacts on the Prey Availability and the Cover and Habitat Complexity attributes:

1. The USACE should encourage the applicant to install location-appropriate native riparian vegetation along the lakeward edge of the replacement bulkhead.

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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