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-2019-00556

February 20, 2020

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

Re: Endangered Species Act Section 7(a)(2) Biological Opinion, and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response for the Lummi Island Ferry Breakwater Replacement Project in Whatcom County, Washington, Fed Aid Number: FBP-A373(001)

Dear Mr. Mathis:

Thank you for your letter on May 16, 2019, 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 Lummi Island Ferry Breakwater Replacement Project. This consultation was conducted in accordance with the 2019 revised regulations that implement section 7 of the ESA (50 CFR 402, 84 FR 45016).

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

The enclosed document contains the biological opinion (Opinion) prepared by the NMFS pursuant to section 7(a)(2) of the ESA on the effects of the proposed action. In this Opinion, the NMFS concludes that the proposed action is not likely to jeopardize the continued existence of Puget Sound (PS) Chinook salmon, PS steelhead, eulachon, Puget Sound/Georgia Basin (PS/GB) bocaccio, Southern Resident killer whales (SRKW), and humpback whales, or to result in the destruction or adverse modification of designated critical habitat for PS Chinook salmon, PS/GB bocaccio, and SRKW.

As required by section 7 of the ESA, the NMFS has provided an incidental take statement with this Opinion. The incidental take statement describes reasonable and prudent measures the NMFS considers necessary or appropriate to minimize the impact of incidental take associated with this action, and sets forth nondiscretionary terms and conditions that the Federal Highway Administration (FHWA) must comply with to meet those measures. Incidental take from actions that meet these terms and conditions will be exempt from the ESA's prohibition against the take of listed species.

This document also includes the results of our analysis of the action's likely effects on EFH pursuant to Section 305(b) of the MSA. The NMFS reviewed the likely effects of the proposed action on EFH, and concluded that the action would adversely affect designated EFH for Pacific Coast groundfish, coastal pelagic species, and Pacific Coast salmon. Therefore, we have included the results of that review in Section 3 of this document.

Please contact Melaina Wright in the North Puget Sound Branch of the Oregon Washington Coastal Office at 206-526-6155, or by email at Melaina.Wright@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: Angel Rivera, FHWA
Cindy Callahan, FHWA
Melanie Vance, WSDOT

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

Lummi Island Ferry Breakwater Replacement Project
Whatcom County, Washington
Fed Aid Number: FBP-A373(001)

NMFS Consultation Number: WCRO-2019-00556

Action Agency: Federal Highway Administration

Affected Species and NMFS' Determinations:

ESA-Listed Species	Status	Is Action Likely to Adversely Affect Species?	Is Action Likely To Jeopardize the Species?	Is Action Likely to Adversely Affect Critical Habitat?	Is Action Likely To Destroy or Adversely Modify Critical Habitat?
Puget Sound steelhead (*Oncorhynchus mykiss*)	Threatened	No	No	N/A	N/A
Puget Sound Chinook (*O. tshawytscha*)	Threatened	Yes	No	Yes	No
Puget Sound/ Georgia Basin bocaccio (*S. paucispinis*)	Endangered	Yes	No	Yes	No
Southern Pacific eulachon (*Thaleichthys pacificus*)	Threatened	No	No	NA	NA
Southern Resident killer whale (*Orcinus orca*)	Endangered	No	No	No	No
Humpback whale Mexico DPS (*Megaptera novaeanglia*)	Threatened	No	No	NA	NA
Humpback whale Central America DPS (*M. novaeanglia*)	Endangered	No	No	NA	NA

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

Fishery Management Plan That Identifies EFH in the Project Area	Does Action Have an Adverse Effect on EFH?	Are EFH Conservation Recommendations Provided?
Coastal Pelagic Species	Yes	Yes

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

Issued By:

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

Date: February 20, 2020

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1. INTRODUCTION

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

1.1 Background

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

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

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

1.2 Consultation History

On January 28, 2019, NMFS received a request to initiate ESA section 7 consultation from the Federal Highway Administration (FHWA). The initiation package included an ESA section 7 consultation initiation letter; biological assessment (BA); Washington State Department of Natural Resources (DNR) best management practices (BMPs) for pile removal and disposal; marine mammal monitoring plan; photographs of the site; pile schedule; and a set of project drawings. The FHWA determined the action may affect but is not likely to adversely affect (NLAA) Puget Sound (PS) Chinook salmon and their critical habitat, PS steelhead, eulachon, Puget Sound/Georgia Basin (PS/GB) bocaccio and their critical habitat, Southern Resident killer whales (SRKW), and humpback whales. The FHWA also determined that the project will not adversely affect EFH.

On February 25, 2019, we informed the FHWA that we could not concur with all of their effects determinations. On May 16, 2019, the FHWA requested formal consultation with NMFS and provided the additional information NMFS requested. The FHWA determined that the project is NLAA PS steelhead, eulachon, humpback whales, and EFH. The FHWA determined that the project is likely to adversely affect (LAA) PS Chinook salmon, PS/GB bocaccio, and SRKW.

NMFS requested additional information on August 19, 2019, which FHWA/WSDOT provided on August 30, 2019. On August 22, 2019, NMFS requested FHWA/WSDOT commit to implementing the project as described, and implement additional conservation measures. On

September 23, 2019, FHWA/WSDOT indicated that the conservation measures were implementable.

On September 26, 2019, FHWA/WSDOT requested to change the in-water work window from August 1 – October 15 to October 1 – December 31. On September 27, 2019 and September 30, 2019, NMFS requested FHWA/WSDOT shorten the newly proposed in-water work window. On October 1, 2019, FHWA/WSDOT indicated that they would conduct work during the original in-water work window of August 1 to October 15. On October 7, 2019, FHWA/WSDOT requested additional work days during the in-water work window. On October 15, 2019, FHWA/WSDOT requested to install additional piles, and increase the duration of pile driving per day.

On October 29, 2019 NMFS sent a formal letter requesting FHWA/WSOT withdraw their request for consultation until they had a firmly defined project description. On December 30, 2019, FHWA/WSDOT submitted a revised project description and marine mammal monitoring plan. On January 9, 2020, NMFS requested additional information. On January 13, 2020, FHWA/WSDOT provided most of that information. Consultation was initiated on that date.

1.3 Proposed Federal Action

"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). For EFH consultation, federal action means any action authorized, funded, or undertaken, or proposed to be authorized, funded, or undertaken by a Federal Agency (50 CFR 600.910).

The FHWA is proposing to authorize the Lummi Island Ferry Breakwater Project in Hale Passage at 2147 North Nugent Road, Lummi Island, Washington (48.720475, -122.681448; Figure 1, Figure 2, Figure 3). The applicant proposes to remove a 90-foot long and an 18-foot long timber pile breakwater at the Lummi Island Ferry Terminal. They propose to replace them with a single 123-foot long steel pile breakwater immediately south of the existing breakwaters (Figure 4, Figure 5).

The applicant will conduct all in-water work between August 1 and October 15. They will work approximately 10 hours per day during daylight hours. They will secure a crane barge and a supply barge in place using three temporary 24-inch steel piles located outside of the surrounding eelgrass beds (Figure 4). They will use a driver to install the temporary piles at the beginning of construction and to extract at the end of construction. They will ensure the barges do not ground and limit the amount of time barges are positioned over eelgrass to two to three days. They will surround the work area with floating containment booms, and pile extraction with a full-depth silt curtain. They will remove 140, 12-inch creosote-treated timber piles using a vibratory driver. If any piles break, they will cut them below the mudline. After they remove the piles, they will place them on the supply barge and truck them to an upland disposal site.

The new breakwater is designed to have a gap along the bottom to reduce scour (Figure 5). The applicant will install 24 breakwater piles, which will consist of 24-inch steel piles with sheets attached. The applicant will use a template to properly space the breakwater piles. The template will allow the applicant to position 6 breakwater piles at a time. They will reposition the template four times to space all 24 breakwater piles. Each time the template is used, it will be held in place by four temporary 12-inch steel piles or H-piles. They will use a vibratory driver to install and extract these temporary piles. In total, 16 temporary piles will be installed and extracted. The applicant will install 18 of the breakwater piles using a vibratory driver and under-ream drill. They will install the remaining 6 breakwater piles using a vibratory driver. They will then install four, 12-inch ammoniacal copper zinc arsenate (ACZA) treated timber fender piles using a vibratory driver. They will not use an impact hammer to proof any of the piles.

Vibratory pile driving and drilling will occur up to 6 hours per day for 39 days. The total duration of vibratory driving and drilling will not exceed 98 hours. In order to minimize noise impacts to marine mammals, the applicant will implement a marine mammal monitoring plan (Appendix A). The applicant will also install steel walers and ridge caps with spikes on top of the piles to reduce predation from birds. They will install one navigation light at the waterward end of the breakwater.

The applicant commits to implementing the project and associated conservation measures identified in the project's BA and the project description above (WSDOT email 2019, 2020). Additionally, the applicant has agreed to the following (WSDOT email 2019, 2020):

1. Install a full-depth silt curtain around pile extraction.
2. Limit vibratory pile removal to vibratory extraction and/or simple pull techniques (no water jetting, no clamshell excavation).
3. Require their contractors and tugboat operators to adjust work practices to ensure that turbidity does not exceed 300 feet from the project site, and to halt work should the visible turbidity plume approach that range in order to reduce exposure to contaminated forage.

We considered whether or not the proposed action would cause any other activities and determined that it would not cause other activities. Though the breakwater will increase safety and reduce wave damage to the ferry slip, ferry activity would continue regardless of the proposed action.

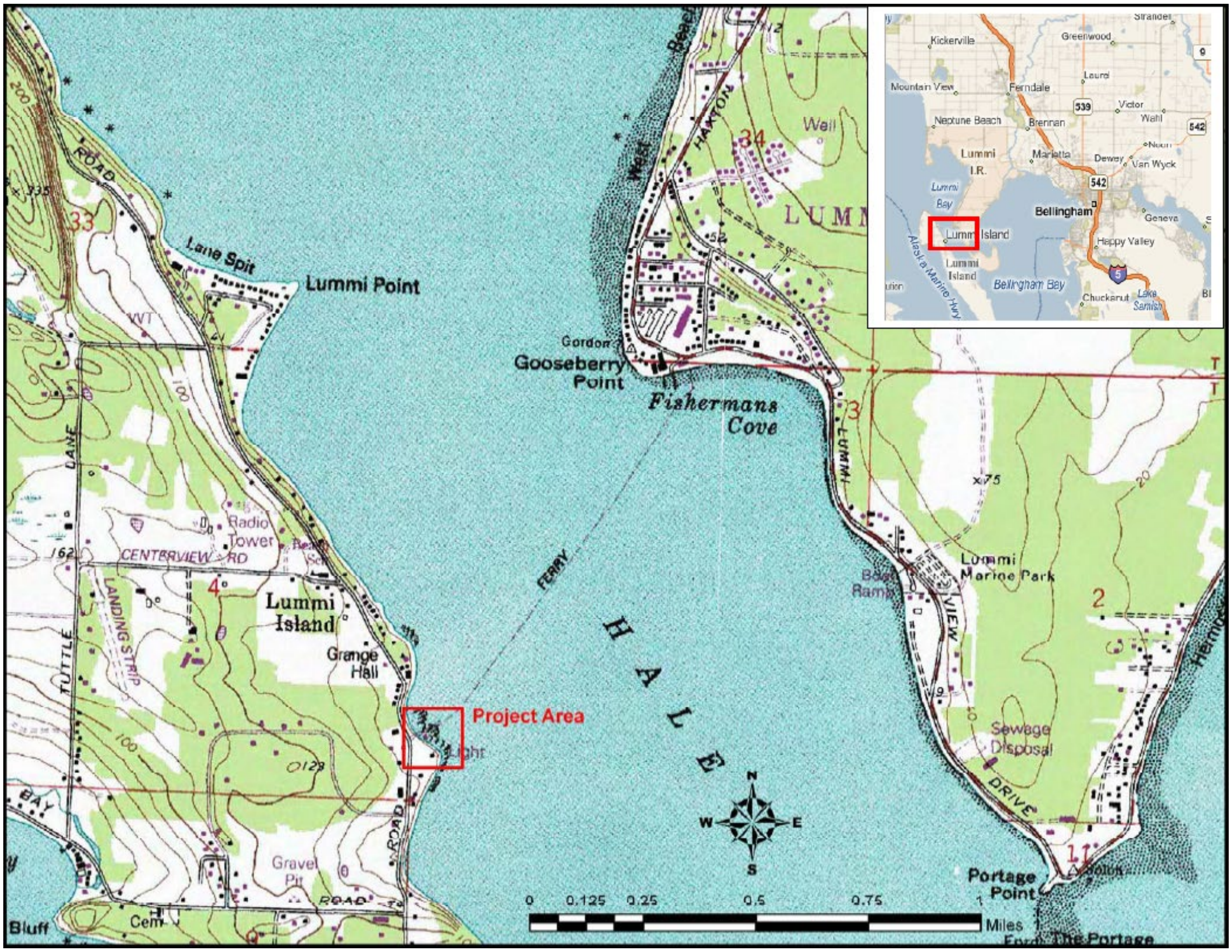

Figure 1. Project site location in Lummi Island, Washington.

Figure 2. Aerial view of project site and vicinity.

Figure 3. Aerial view of project area.

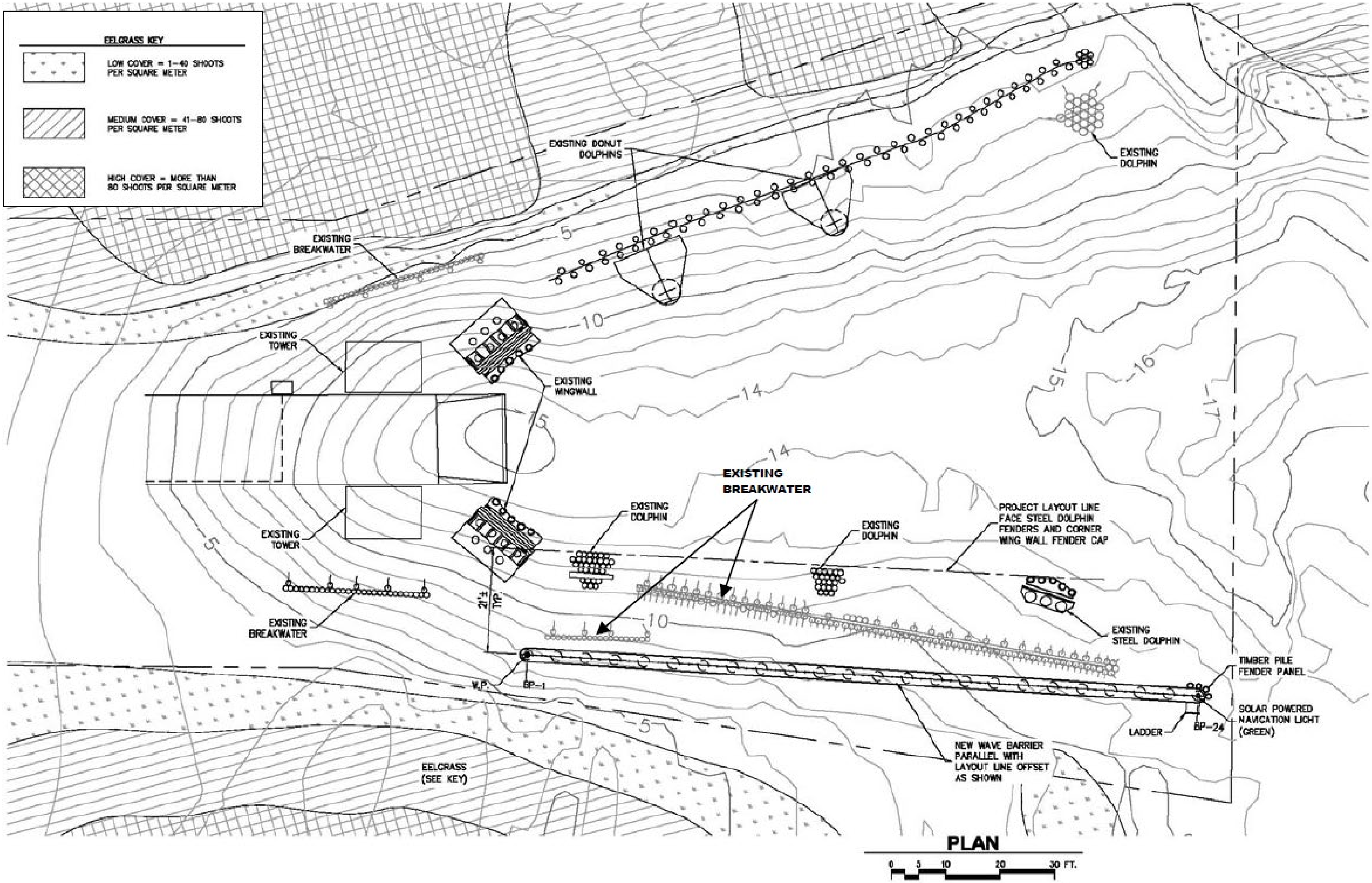

Figure 4. Location of the existing breakwaters and the proposed breakwater.

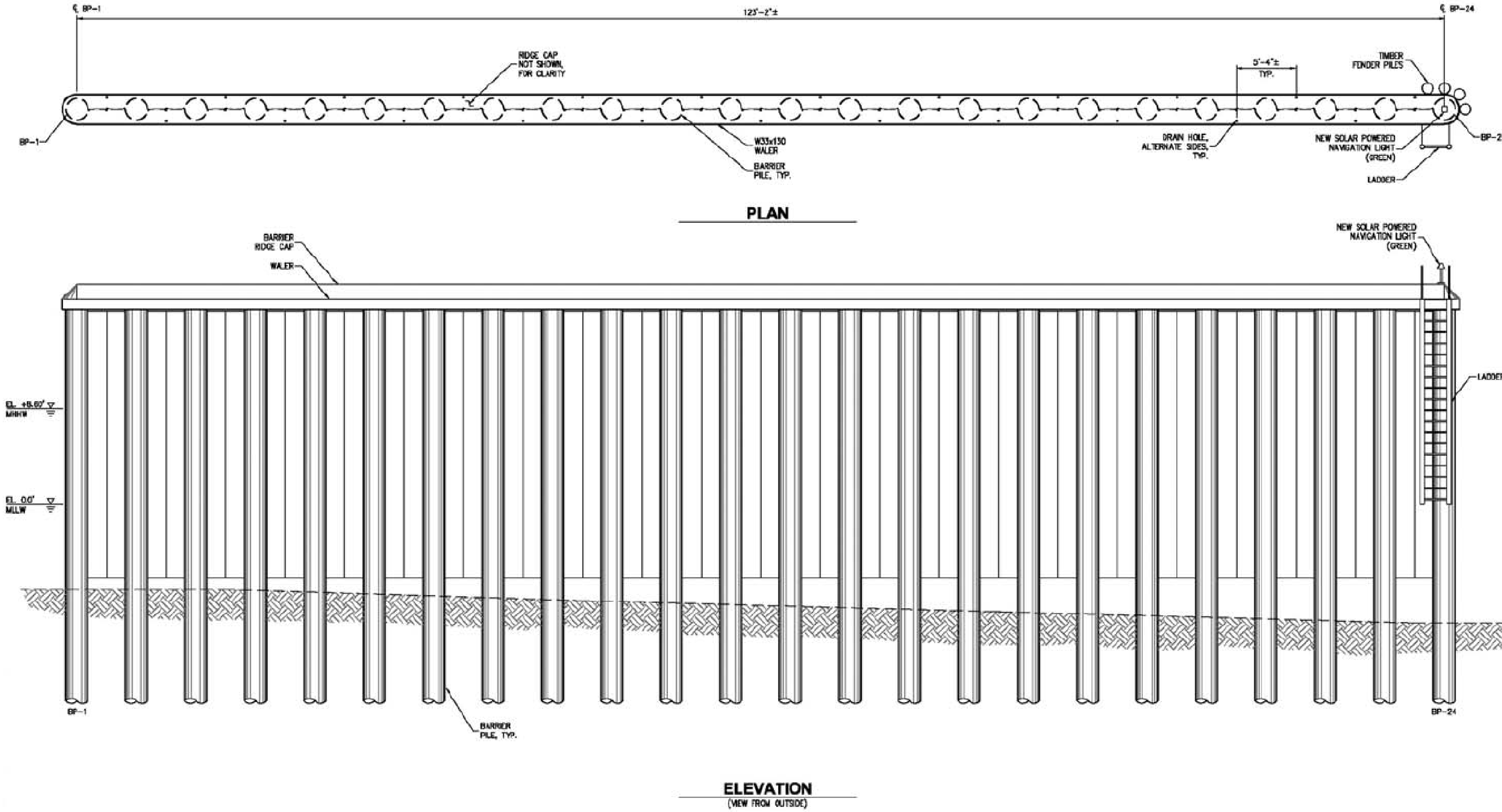

Figure 5. Detail of the new proposed breakwater

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

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

Although the FHWA proposed a NLAA determination for Southern distinct population segment (DPS) eulachon, NMFS determined that the proposed action would have no effect on the species. There are no known populations of eulachon in Puget Sound east of the Elwha River, and critical habitat for this species does not include Puget Sound (NMFS 2017a). The FHWA proposed a NLAA determination for humpback whales and PS steelhead. Our concurrence is documented in the "Not Likely to Adversely Affect" Determinations section (Section 2.12). Although the FHWA proposed a LAA determination for SRKW, NMFS determined that the proposed action is NLAA this species. Our determination is documented in Section 2.12.

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 CFR402.02). Therefore, the jeopardy analysis considers both survival and recovery of the species.

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

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

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

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

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

2.2 Rangewide Status of the Species and Critical Habitat

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

One factor affecting the status of ESA-listed species considered in this opinion, and aquatic habitat at large, is climate change. Climate change is likely to play an increasingly important role in determining the abundance and distribution of ESA-listed species, and the conservation value of designated critical habitats, in the Pacific Northwest. These changes will not be spatially homogeneous across the Pacific Northwest. The largest hydrologic responses are expected to occur in basins with significant snow accumulation, where warming decreases snow pack, increases winter flows, and advances the timing of spring melt (Mote et al. 2016; Mote et al. 2014). Rain-dominated watersheds and those with significant contributions from groundwater may be less sensitive to predicted changes in climate (Mote et al. 2014; Tague et al. 2013).

During the last century, average regional air temperatures in the Pacific Northwest increased by 1-1.4°F as an annual average, and up to 2°F in some seasons based on average linear increase per decade (Abatzoglou et al. 2014; Kunkel et al. 2013). Warming is likely to continue during the next century as average temperatures are projected to increase another 3 to 10°F, with the largest increases predicted to occur in the summer (Mote et al. 2014). Decreases in summer precipitation of as much as 30 percent by the end of the century are consistently predicted across climate models (Mote et al. 2014). Precipitation is more likely to occur during October through March, less during summer months, and more winter precipitation will be rain than snow (ISAB 2007; Mote et al. 2013; Mote et al. 2014). Earlier snowmelt will cause lower stream flows in late spring, summer, and fall, and water temperatures will be warmer (ISAB 2007; Mote et al. 2014). Models consistently predict increases in the frequency of severe winter precipitation events (i.e., 20-year and 50-year events), in the western United States (Dominguez et al. 2012). The largest increases in winter flood frequency and magnitude are predicted in mixed rain-snow watersheds (Mote et al. 2014).

Overall, about one-third of the current cold-water salmonid habitat in the Pacific Northwest is likely to exceed key water temperature thresholds by the end of this century (Mantua et al. 2009). Higher temperatures will reduce the quality of available salmonid habitat for most freshwater life stages (ISAB 2007). Reduced flows will make it more difficult for migrating fish to pass physical and thermal obstructions, limiting their access to available habitat (Isaak et al. 2012; Mantua et al. 2010). Temperature increases shift timing of key life cycle events for salmonids and species forming the base of their aquatic foodwebs (Crozier et al. 2011; Tillmann and Siemann 2011; Winder and Schindler 2004). Higher stream temperatures will also cause decreases in dissolved oxygen and may also cause earlier onset of stratification and reduced mixing between layers in lakes and reservoirs, which can also result in reduced oxygen (Meyer et al. 1999; Raymondi et al. 2013; Winder and Schindler 2004). Higher temperatures are likely to cause several species to become more susceptible to parasites, disease, and higher predation rates (Crozier et al. 2008; Raymondi et al. 2013; Wainwright and Weitkamp 2013).

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

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

Moreover, as atmospheric carbon emissions increase, increasing levels of carbon are absorbed by the oceans, changing the pH of the water. Acidification also impacts sensitive estuary habitats, where organic matter and nutrient inputs further reduce pH and produce conditions more corrosive than those in offshore waters (Feely et al. 2012; Sunda and Cai 2012).

Global sea levels are expected to continue rising throughout this century, reaching likely predicted increases of 10 to 32 inches by 2081 to 2100 (IPCC 2014). These changes will likely result in increased erosion and more frequent and severe coastal flooding, and shifts in the composition of nearshore habitats (Reeder et al. 2013; Tillmann and Siemann 2011). Estuarine-dependent salmonids such as chum and Chinook salmon are predicted to be impacted by significant reductions in rearing habitat in some Pacific Northwest coastal areas (Glick et al. 2007).

Historically, warm periods in the coastal Pacific Ocean have coincided with relatively low abundances of salmon and steelhead, while cooler ocean periods have coincided with relatively high abundances, and therefore these species are predicted to fare poorly in warming ocean conditions (Scheuerell and Williams 2005; Zabel et al. 2006). This is supported by the recent observation that anomalously warm sea surface temperatures off the coast of Washington from 2013 to 2016 resulted in poor coho and Chinook salmon body condition for juveniles caught in those waters (NWFSC 2015). Changes to estuarine and coastal conditions, as well as the timing of seasonal shifts in these habitats, have the potential to impact a wide range of listed aquatic species (Reeder et al. 2013; Tillmann and Siemann 2011).

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

2.2.1 Status of the Species

This section provides a summary of listing and recovery plan information, status, and limiting factors for the species addressed in this opinion. More information can be found in recovery plans and status reviews for these species. These documents are available on the NMFS West Coast Region website (http://www.fisheries.noaa.gov/).

Puget Sound Chinook salmon

We listed the PS Chinook salmon ESU as threatened on June 28, 2005 (70 FR 37160). Recovery plans for PS Chinook salmon include the Shared Strategy for Puget Sound 2007 Plan and the NMFS 2006 Plan (NMFS 2006; SSDC 2007). The most recent status review was in 2015 (NWFSC 2015). This ESU comprises 22 populations distributed over five geographic areas. Most populations within the ESU have declined in abundance over the past 7 to 10 years, with widespread negative trends in natural-origin spawner abundance and hatchery-origin spawners present in high fractions in most populations outside of the Skagit watershed. Escapement levels for all populations remain well below the Technical Recovery Team (TRT) planning ranges for recovery, and most populations are consistently below the spawner-recruit levels identified by the TRT as consistent with recovery.

Limiting factors for PS Chinook salmon include:
1. Degraded floodplain and in river channel structure.
2. Degraded estuarine conditions and loss of estuarine habitat
3. Degraded riparian areas and loss of in river large woody debris
4. Excessive fine-grained sediment in spawning gravel
5. Degraded water quality and temperature
6. Degraded nearshore conditions
7. Impaired passage for migrating fish
8. Severely altered flow regime

Puget Sound / Georgia Basin Bocaccio
We listed the PS/GB bocaccio DPS as endangered on April 28, 2010 (75 FR 22276). A recovery plan for PS/GB bocaccio was published by NMFS in 2017 (NMFS 2017b). The most recent status review was in 2016 (NMFS 2016). Though bocaccio were never a predominant segment of the multi-species rockfish population within the PS/GB, their present-day abundance is likely a fraction of their pre-contemporary fishery abundance. Most bocaccio within the DPS may have been historically spatially limited to several basins within the DPS. They were apparently historically most abundant in the Central and South Sound with no documented occurrences in the San Juan Basin until 2008. The apparent reduction of populations of bocaccio in the Main Basin and South Sound represents a further reduction in the historically spatially limited distribution of bocaccio, and adds significant risk to the viability of the DPS.

Limiting factors for PS/GB bocaccio include:
1. Over harvest
2. Water pollution
3. Climate-induced changes to rockfish habitat
4. Small population dynamics

2.2.2 Status of the Critical Habitat

Puget Sound Chinook Salmon
We designated critical habitat for PS Chinook salmon on September 2, 2005 (70 FR 52630). Critical habitat for PS Chinook salmon includes 1,683 miles of streams, 41 square miles of lakes, and 2,182 miles of nearshore marine habitat in PS. The PS Chinook salmon ESU has 61 freshwater and 19 marine areas within its range. Of the freshwater watersheds, 41 are rated high conservation value, 12 low conservation value, and eight received a medium rating. Of the marine areas, all 19 are ranked with high conservation value. Marine habitat threats include urbanization, wetland draining and conversion, dredging, armoring of shorelines, and marina and port development. These activities have diminished the availability and quality of nearshore marine habitats and reduced water quality across the region.

Puget Sound/Georgia Basin Bocaccio
We designated critical habitat for the PS/GB DPS of bocaccio on November 13, 2014 (79 FR 68042). Critical habitat for bocaccio rockfish includes 590.4 square miles of nearshore habitat and 414.1 square miles of deepwater habitat. Critical habitat is not designated in areas outside of United States jurisdiction; therefore, although waters in Canada are part of the DPSs' ranges for this species, critical habitat was not designated in that area. Based on the natural history of bocaccio and their habitat needs, NMFS identified two PBFs, essential for their conservation: 1) Deepwater sites (>30 meters) that support growth, survival, reproduction, and feeding opportunities; 2) Nearshore juvenile rearing sites with sand, rock and/or cobbles to support forage and refuge. Habitat threats include degradation of rocky habitat, loss of eelgrass and kelp, introduction of non-native species that modify habitat, and degradation of water quality as specific threats to rockfish habitat in the Georgia Basin.

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 action area for this project includes the footprint of the project and adjacent aquatic areas within approximately 3.9 miles due to the spatial extent of underwater sound for marine mammals.

2.4 Environmental Baseline

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

The Lummi Island Ferry Terminal is located on the eastern shoreline of Lummi Island along a manmade riprap peninsula located in the center of a small cove and a gravel/cobble pocket beach with low sandstone ridges (Figure 2). Large eelgrass beds surround either side of the existing breakwaters (Figure 4). Eelgrass is located approximately 25 to 30 feet away from the existing breakwaters and 10 feet away from the proposed breakwater Water depth is approximately -7 to -12 feet below mean lower low water (MLLW). According to the Washington State Forage Fish Spawning Map (WDFW 2018), Pacific herring and surf smelt spawning have been documented in the action area. Surf smelt spawning is expected to occur year-round (Penttila 2007). Pacific herring spawning is expected to occur between February and April (Penttila 2007), which is outside the in-water work window.

Past and ongoing anthropogenic impacts, including climate change, described in Section 2.2, have impacted ESA-listed species and critical habitat present in the action area. The shoreline is moderately developed with residential homes, commercial structures, and public infrastructure. Underwater noise is characterized by the ferry, which operates up to 18 hours a day during and after daylight hours (Whatcom County 2019). The action area not listed on the Washington State 303(d) list of impaired waterways for sediment and water quality (Ecology 2018). However, the existing 90-foot long and 18-foot long breakwaters consist of creosote-treated piles, which have likely contaminated sediments in the immediate area surrounding the piles.

Juvenile PS Chinook are nearshore oriented (Fresh 2006). Peak juvenile abundance in the nearby Bellingham Bay is expected to occur from January through August (Beamer et al. 2016), with some occurring in October (Rice et al. 2011). Adult PS Chinook can reside in PS year-round, and return to their natal river between June and September.

Rockfish fertilize their eggs internally and extrude the young as larvae (Love et al. 2002). Rockfish larvae are typically found in the pelagic zone, often occupying the upper layers of open waters, under floating algae, detached seagrass, and kelp. Rockfish larvae are thought to be mostly distributed passively by currents (Love et al. 2002). Surveys indicate that larval rockfish are present during February in the nearby Bellingham Bay (Greene and Godersky 2012). Therefore, rockfish larvae are extremely unlikely to occur during the in-water work window.

Juvenile rockfish move from the pelagic environment and associate with the benthic environment when they reach about 30 to 90 millimeters in length at approximately 3 to 6 months of age (Love et al. 2002). Juvenile bocaccio are known to settle onto rocky or cobble substrates in the shallow nearshore in areas that support kelp and sandy zones with eelgrass or drift algae. They move to progressively deeper waters as they grow (Love et al. 2002; Palsson et al. 2009).

Adult bocaccio typically occupy waters deeper than 300 feet and 165 feet, respectively (Love et al. 2002) and prefer rocky habitats. Given these depths do not occur in the action area, it is extremely unlikely that adult PS bocaccio will occur within the shallow water in the action area.

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

2.5.1 Effects to Listed Species

Underwater Noise

NMFS established the injury thresholds for impulsive sound at 206 dB peak, 187 dB cumulative sound exposure level (SEL_{cum}) for fish more than 2 grams, and 183 dB SEL_{cum} for fish less than

2 grams (Fisheries Hydroacoustic Working Group 2008). The behavioral disturbance threshold is 150 dB root mean square (RMS). Any received level below 150 dB sound exposure level (SEL) is considered "Effective Quiet" (Stadler and Woodbury 2009).

Pile extraction/installation

Vibratory pile driving produces a lower level continuous noise (Duncan et al. 2010) that does not injure fish. Fish consistently avoid sounds like those of a vibratory hammer (Dolat 1997; Enger et al. 1993; Knudsen et al. 1997; Sand et al. 2000) and appear not to habituate to these sounds, even after repeated exposure (Dolat 1997; Knudsen et al. 1997). Illingworth & Rodkin (2017) report an underwater sound level of 158 dB RMS at 10 meters for vibratory driving of timber piles. The noise from the timber pile installation/extraction will attenuate to 150 dB RMS within 34 meters. Caltrans (2015) reported underwater noise 10 meters from vibratory driving 24-inch steel piles that yielded underwater sound levels of 153 dB RMS, 155 dB RMS from vibratory driving 12-inch steel piles, and 150 dB RMS from vibratory driving 12-inch steel H-piles. The noise from the 24-inch steel pile installation/extraction will attenuate to 150 dB RMS within 16 meters, 22 meters for 12-inch steel piles, 10 meters for 12-inch steel H-piles.

Nedwell and Brooker (2008) reported underwater noise at 1 meter from drilling a 46-inch diameter hole into bedrock that yielded underwater sound levels of 162 dB SEL and 162 dB RMS (re: 1μPa). Based on the Illingworth and Rodkin (2012) Compendium, dB peak is typically 10 to 15 dB higher than dB RMS. We expect the noise from the drilling of the 24-inch holes for the pilings to be less than or equal to these values. The noise from drilling will attenuate to 150 dB RMS within 63 meters.

Without an estimate of the duration of drilling, pile installation and extraction, we conservatively assume that the activity with the largest area of acoustic effect (drilling) will occur for the entire duration of in-water work (6 continuous hours a day for a total of 98 hours over 39 days). Any fish that remains within 63 meters of drilling for the entire 6-hour duration in a single day would likely experience physiological impacts on auditory and non-auditory soft tissues from accumulated sound energy. The severity and permanence of those impacts would depend on the range from the source and the duration of the exposure, with intensity decreasing with increased distance and/or reduced length of exposure. Adult PS Chinook salmon will be larger than 2 grams, highly mobile, and will be migrating past the site in route to their natal streams. Therefore, they are unlikely to accumulate injurious levels of sound energy. However, juvenile PS Chinook salmon and juvenile PS/GB bocaccio are likely to remain in the action area given the presence of rearing habitat, and accumulate injurious levels of sound energy.

Juvenile PS Chinook salmon and PS/GB bocaccio within 63 meters of drilling are likely to experience behavioral disturbance. 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). Adult PS Chinook are not nearshore dependent but may pass through the area of acoustic effect during migration. Any adult that may occur could be displaced from the area within 63 meters of drilling. Avoidance of this area would not cause measurable effects on the fitness of exposed adults.

The number of individual PS Chinook salmon and PS/GB bocaccio that would be affected by this stressor is unquantifiable with any degree of certainty. However, the affected individuals would represent such small subsets of their respective cohorts that the numbers of exposed fish would be too low to cause detectable population-level effects.

Vessels

Tugboat-related noise would likely consist of episodic events of 1 to 2 hours when the tugboat is present to move barges. The best available information for source levels is Veirs et al. (2016). Source levels are estimated to be 170 dB ± 5 dB for tugboats (Veirs et al. 2016). However, the available information describes tugboats running at or close to full-speed, which is likely to overestimate exposure risk. Because SEL is often identical to RMS for non-impulsive sources, we assume that reported sound levels by Veirs et al. (2016) are in dB RMS which would, at worst, overestimate sound levels. To conservatively estimate source levels, we also assume that the mean plus the standard deviation represents the source level.

Given a source level of 175 dB, we conservatively assume that the area of continuous acoustic affect (above 150 dB SEL) will include all of the water within 46 meters of the barges. The area of continuous acoustic effect will overlap with the eelgrass bed, where juvenile PS Chinook salmon and juvenile PS/GB bocaccio are most likely to occur. As described above, exposed individuals may experience an increased risk of predation due to acoustic masking and other behavioral responses. The number of individual PS Chinook salmon and PS/GB bocaccio that would be affected by this stressor is unquantifiable with any degree of certainty. However, the affected individuals would represent such small subsets of their respective cohorts that the numbers of exposed fish would be too low to cause detectable population-level effects.

As discussed in Section 2.4, adult PS Chinook salmon are not nearshore dependent but may pass through the area of acoustic effect during migration. Given the small size of the area of acoustic effect and availability of similar habitat in the surrounding area, any avoidance of the action area will not have a meaningful effect on adult PS Chinook salmon.

Underwater noise may affect forage fish. However, the number of forage fish injured or killed would be too small to cause detectable effects on their populations in the action area. Therefore, construction-related forage reductions would be too small to cause detectable effects on ESA-listed species.

Turbidity

In-water pile removal and driving and spud placement will cause short-term and localized increases in turbidity and total suspended solids (TSS). For reference, vibratory removal of hollow 30-inch steel piles in Lake Washington mobilized sediments that adhered to the piles as they were drawn through the water column, with much of the mobilized sediments being material that fell out of the hollow piles (Bloch 2010). Turbidity reached a peak of about 25 mg/L above background levels at 50 feet from the pile, and about 5 mg/L above background at 100 feet. Turbidity returned to background levels within 30 to 40 minutes. Pile installation created much lower turbidity. We expect that little turbidity will result from placement of spud piles and vibratory installation of 24-inch steel piles under the proposed project. The proposed vibratory extraction of timber piles for this project is likely to mobilize far less sediment than the piles described above, because the timber piles are less than half the size (less surface area for sediments to adhere to) and they are solid (no tube to hold packed-in sediments). Further, extracted piles will be surrounded by a full depth silt curtain. Therefore, the mobilization of bottom sediments, and resulting turbidity from the planned pile removal is likely to be less than that reported by Bloch. We expect that mobilized sediments during pile extraction will not exceed 300 feet from the project site (NMFS 2017c).

The effects of turbidity on fish are 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. Newcombe and Jensen (1996) reported minor physiological stress in juvenile salmon only after about three hours of continuous exposure to concentration levels of about 700 to 1,100 mg/L. To the extent that PS Chinook salmon and PS/GB bocaccio are present in the areas with elevated suspended sediment, they are expected to be of sufficient size to swim away from these areas, which would also limit the potential for, and duration of, exposure. Construction-related turbidity would be very short-lived and at concentrations too low to cause more than temporary, non-injurious behavioral effects (e.g., avoidance of the plume) or a temporary reduction in feeding activity (Newcombe and Jensen 1996). None of these potential responses, individually, or in combination are likely to adversely affect exposed individuals.

Tugboats may be used during demolition of the existing breakwaters and installation of the new breakwater. A recent study described the turbidly cause by tugboats operations in water about 40 feet (12 meters) deep (ESTCP 2016). At about 13 minutes, the plume extended about 550 yards (500 meters) and had a TSS concentration of about 80 mg/L. The plume persisted for many hours and extended far from the event. However, the TSS concentration fell to 30 mg/L within 1 hour and to 15 mg/L within 3 hours. Turbidity generated by waves breaking on the structure is expected to be at concentrations less than or equal these values. Vessel- and structure-related turbidity would be temporary and at concentrations too low to cause more than temporary, non-injurious effects as described above. Therefore, it is not expected to affect the fitness of exposed individuals.

As discussed in Section 2.4, eelgrass is present 25 to 30 feet away from the existing breakwaters and 10 feet away from the proposed breakwater. Any shading of submerged aquatic vegetation (SAV) from increased TSS is expected to be short-lived. Should eelgrass be damaged, it is expected to recover within 24 months (Boese et al. 2009). Any eelgrass affected would be a small part of the total available eelgrass near the project site. Therefore, effects are unlikely to be detectable in juvenile PS Chinook salmon and PS/GB bocaccio.

Dissolved Oxygen

Mobilization of anaerobic sediments can decrease dissolved oxygen (DO) levels (Hicks et al. 1991; Morton 1976). However, as described above, only a small amount of sediment will be mobilized by construction activities. This suggests that any impacts on DO will be too small and short-lived to cause detectable effects in exposed fish.

Contaminants

Presently, creosote-treated piles contaminate the surrounding sediment up to two meters away with polycyclic aromatic hydrocarbon, or PAHs (Evans et al. 2009). Cutting or removing the creosote-treated piles mobilizes these PAHs into the surrounding water and sediments (Parametrix 2011; Smith 2008). The project will also release PAHs directly from creosote-treated timber if any of the piles break during removal (Parametrix 2011). Vessels and structure-related scour may increase turbidity The concentration of PAHs released into surface water rapidly dilutes. Smith (2008) reported concentrations of total PAHs of 101.8 μg/L 30 seconds after creosote-pile removal and 22.7 μg/L 60 seconds after. However, PAH levels in the sediment after pile removal can remain high for six months or more (Smith 2008). Romberg (2005) found a major reduction in sediment PAH levels three years after pile removal contaminated an adjacent sediment cap. As described above, vessels and structure-related scour may mobilize sediments that are contaminated.

There are two pathways for PAH exposure to listed fish species in the action area, direct uptake through the gills and dietary exposure (Karrow et al. 1999; Lee and Dobbs 1972; McCain et al. 1990; Meador et al. 2006; Neff et al. 1976; Roubal et al. 1977; Varanasi et al. 1993). Fish rapidly uptake PAHs through their gills and food but also efficiently remove them from their body tissues (Lee and Dobbs 1972; Neff et al. 1976). Juvenile Chinook salmon prey, including amphipods and copepods, uptake PAHs from contaminated sediments (Landrum et al. 1984; Landrum and Scavia 1983; Neff 1982).Varanasi et al. (1993) found high levels of PAHs in the stomach contents of juvenile Chinook salmon in the Duwamish estuary.

The primary effects of PAHs on salmonids from both uptake through their gills and dietary exposure are immunosuppression and reduced growth. Karrow et al. (1999) characterized the immunotoxicity of creosote to rainbow trout (*Oncorhynchus mykiss*) and reported a lowest observable effect concentration for total PAHs of 17 μg/L. Varanasi et al. (1993) found greater immune dysfunction, reduced growth, and increased mortality compared to control fish. In order to isolate the effects of dietary exposure of PAHs on juvenile Chinook salmon, Meador et al. (2006) fed a mixture of PAHs intended to mimic those found by Varanasi et al. (1993) in the stomach contents of field-collected fish. These mixture-fed fish showed reduced growth compared to the control fish.

Vibratory pile removal will be limited to vibratory extraction and/or simple pull techniques and will be surrounded by a full depth silt curtain, which will limit contamination. NMFS expects the water and substrate within 300 feet of pile removal activities and structure-related scour (NMFS 2017c), and within 550 yards of vessel activity (ESTCP 2016) will have increased levels of PAHs. Within this area, contaminants may be biologically available for years, at steadily decreasing levels. While present, contaminants such as PAHs are likely to bioaccumulate in benthic invertebrates (Landrum et al. 1984; Landrum and Scavia 1983; Neff 1982), some of which will be consumed by listed fish that forage in the action area. Fish have low PAH uptake retention (Niimi and Dookhran 1989; Niimi and Palazzo 1986) and metabolize PAHs rapidly (Hellou and Payne 1986; Roubal et al. 1977; Statham et al. 1978; Varanasi et al. 1989). Nevertheless, even brief exposure to PAH-contaminated habitats has been shown to reduce growth, suppress immune competence, and increased mortality in outmigrating juvenile Chinook salmon (Meador et al. 2006; Varanasi et al. 1993). Juvenile bocaccio may consume contaminated forage as they are likely to be present within the SAV along the breakwater. It is unlikely that adult salmonids and rockfish that feed on forage fish would be impacted as biomagnification of PAHs does not occur in fish (Suedel et al. 1994).

The annual number of juvenile Chinook salmon and PS/GB bocaccio that may be exposed to PAH-contaminated forage that will be attributable to this action is unquantifiable with any degree of certainty, as is the amount of contaminated prey that any individual fish may consume, or the intensity of any effects that an exposed individual may experience. However, the small affected area and the low volume of contaminated sediment that would be brought to the surface suggest that the probability of trophic connectivity to the contamination would be very low for any individual fish. Therefore, the numbers of fish that may be exposed to contaminated prey annually will be very low, and no detectable effects at the population level for Chinook salmon are expected.

Construction-related vessels may discharge petroleum-based fuels and lubricants that contain PAHs. The discharges are expected to be infrequent and small. The fuels and lubricants that will be used tend to evaporate quickly, with PAH dissipating within a few hours (Werme et al. 2010). Further, the area is exposed to regular strong tidal currents that will quickly dilute and mix discharged fuels and lubricants, and facilitate the evaporation and/or bioremediation of any petroleum-based chemicals that may be released. Based on the available information, the concentrations and residence times of vessel-related petroleum-based substances will be too low to cause detectable effects.

Obstruction and Shade

The new breakwater will be in relatively shallow water (-7 to -12 feet below MLLW). The solid structure will produce an intense shadow. Intense shade can limit primary production and reduce the diversity of the aquatic communities under over-water structures (Nightingale and Simenstad 2001; Simenstad et al. 1999). Construction-related barges and vessels will also cast a shadow. As discussed above, eelgrass is present 25 to 30 feet away from the existing breakwaters and 10 feet away from the proposed breakwater. Its shade is likely to prevent or reduce adjacent SAV growth, and reduce the production and diversity of invertebrate organisms that are prey for juvenile Chinook salmon and bocaccio. However, the small size of the total affected area as compared to the rest of the benthic habitat at this site, suggest that any reduction in the availability of cover and/or prey for juvenile PS Chinook salmon and juvenile PS/GB bocaccio will be undetectable.

The 123-foot long breakwater will be larger than the existing breakwaters combined. The new breakwater is likely to physically obstruct the movement of juvenile salmon (Williams and Thom 2001). The shadow produced by the breakwater and construction-related vessels may also impede the movement of juvenile salmon. Numerous studies demonstrate that juvenile salmon, in both marine and freshwater habitats, are more likely to avoid the shadow of an overwater structure than to pass through the shadow (Celedonia et al. 2008a; Celedonia et al. 2008b; Kemp et al. 2005; Moore et al. 2013; Munsch et al. 2014; Nightingale and Simenstad 2001; Ono et al. 2010; Southard et al. 2006). Though there will be a gap under the breakwater (Figure 5), it is unlikely that juvenile PS Chinook salmon will pass through its shadow.

An implication is that some juvenile salmon will swim around the structure (Nightingale and Simenstad 2001). This behavioral modification will cause them to temporarily utilize deeper habitat, thereby exposing them to increased piscivorous predation. This has been shown in the marine environment where juvenile salmonid consumption by piscivorous predators increased fivefold when juvenile pink salmon were forced to leave the shallow nearshore (Willette 2001). Further, swimming around overwater structures lengthens the salmonid migration route, which is correlated with increased mortality (Anderson et al. 2005).

In summary, the increase in migratory path length from swimming around the breakwater, as well as the increased exposure to piscivorous predators in deeper water will likely result in proportionally increased juvenile PS Chinook mortality. The annual number of juvenile PS Chinook salmon that may be exposed to increased predation and longer migration distances attributable to this action is unquantifiable with any degree of certainty. However, the small affected area suggests that the probability of mortality would be very low for any individual fish. Therefore, the numbers of fish that may be annually exposed to increased predation and longer migration distances will be very low, and no detectable effects at the population level are expected.

Adult PS Chinook salmon are large, highly mobile, and typically utilize habitat deeper than the area surrounding the breakwater. Therefore, they are not likely to be exposed to increased predation or longer migration distances. Unlike salmonids, juvenile rockfish migration and risk of predation are not known to be adversely impacted by artificial structures (Love et al. 2002). The aggregation of some rockfish near docks, piers, and other artificial structure suggests that, harm is unlikely to occur to juvenile PS/GB bocaccio from those structures.

Artificial Lighting

Construction will not occur outside of daylight hours. The new breakwater will have one navigation light at its waterward end, which will be located far above the water's surface (Figure 5). Therefore, NMFS expects that in-water light levels at the site that would be attributable to the proposed action would only be minimally detectable and too low to cause meaningful effects in the fitness or normal behaviors of juvenile PS Chinook salmon and PS/GB bocaccio, which may occur in the eelgrass beds surrounding the breakwater.

Propeller Wash and Scour

Killgore et al. (2011) report that fish are killed by spinning boat propellers. Propeller-related turbulence has also been documented to kill small aquatic organisms like copepods (Bickel et al. 2011). Small fish that are exposed to propeller wash may also be displaced by the fast-moving turbulent water. Propeller wash is unlikely to affect adult PS Chinook salmon, because they are unlikely to approach close enough to operating vessels to be exposed. In the unlikely event of adult exposure, their increased size and swimming ability suggest that they will swim away from the propeller wash with no detectable effects other than a very brief avoidance behavior. Juvenile PS/GB bocaccio are unlikely to be affected as they are associated with benthic habitat away from the surface where effects are likely to occur.

Juvenile PS Chinook salmon are likely to be relatively close to the surface where they may be exposed to spinning propellers and propeller wash, and will be too small to effectively swim against the turbulent water. Therefore, juvenile PS Chinook salmon may be injured, killed, or displaced by construction and structure-related propellers and propeller wash. The number of individuals that may be impacted by this stressor is unquantifiable with any degree of certainty.

However, based on the expectation that exposed individuals would be very small subsets of the cohorts from their respective populations, the numbers of exposed fish will be too low to cause detectable population-level effects.

Propellers may injure or kill forage fish. However, the number of forage fish injured or killed would be too small to cause detectable effects on their populations in the action area. Therefore, construction-related forage reductions would be too small to cause detectable effects on ESA-listed species.

Propellers and propeller wash can also mobilize sediments and dislodge aquatic organisms. In shallow water, propeller scour can reduce SAV and diminish the density and diversity of the benthic community. Though construction-related vessels would likely operate at low power levels, they would be situated over relatively shallow water (-7 to -12 feet below MLLW). Therefore, propeller scour may reduce SAV and other benthic resources adjacent to the breakwater. SAV is expected to recover within 24 months (Boese et al. 2009), and recolonization of benthic invertebrates is expected to occur within weeks to months (McCabe et al. 1998). The small size of the total affected area as compared to the rest of the benthic habitat at this site, suggest that any reduction in the availability of cover and/or prey for juvenile PS Chinook salmon and juvenile PS/GB bocaccio will be undetectable.

Structure-Related Scour
Like propeller scour, structure-related scour can mobilize sediments and dislodge aquatic organisms. The new breakwater will have a gap along the bottom to allow enough wave energy to pass beneath the wall to maintain the same level of scour as the existing breakwater. However, the new breakwater will be larger and closer to existing eelgrass. In this new location, tidal scour may reduce the growth of adjacent SAV and the abundance of benthic invertebrates into the foreseeable future. However, the small size of the total affected area as compared to the rest of the benthic habitat at this site, suggest that any reduction in the availability of cover and/or prey for juvenile PS Chinook salmon and juvenile PS/GB bocaccio will be undetectable.

2.5.2 Effects to Critical Habitat

Puget Sound Chinook Salmon
Designated critical habitat within the action area for PS Chinook salmon consists of estuarine and marine rearing sites, migration corridors, and their essential physical and biological features. The PBFs of PS Chinook salmon critical habitat in the action area are nearshore marine areas free of obstruction with water quality and quantity conditions and forage, including aquatic invertebrates and fishes, supporting growth and maturation; and natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, and side channels.

Free of Obstruction and Excessive Predation
The proposed action will cause long-term minor effects on obstruction and episodic ephemeral effects on predation. Construction will cause episodic ephemeral elevated noise, activity, and reduced water quality that may cause temporary avoidance of the area by low numbers of PS Chinook salmon. The proposed action will also maintain a longstanding structure that may affect shoreline migration by juveniles. The proposed action will cause no change in the abundance of

predators, but the presence of the structure and construction-related noise may cause increased predation on juveniles. The proposed action will act to maintain this PBF at a reduced functional level compared to undisturbed areas. Therefore, the action will cause a long-term minor change in the quality and function of this PBF.

Water Quality
The action will eliminate sources of ongoing PAH water contamination through the removal of the existing structure's creosote-treated piles. Construction will briefly mobilize contaminated sediments, and may also very slightly reduce DO in very limited areas. Detectable construction-related effects on water quality are expected to be limited to the area well within 300 feet around pile installation/removal and 550 yards of vessel activity, and are not expected to persist past one or two hours after work stops. However, structure-related scour will episodically increase turbidity and mobilize contaminants in the sediment. Therefore, the action will cause a long-term minor change in the quality and function of this PBF.

Water Quantity
The proposed action will have no effect on water quantity, and will cause no change in the quality and function of this PBF.

Forage
Construction-related noise and propellers may injure or kill forage fish that may occur in the action area. However, the number of individuals injured or killed would be too small to cause population-level effects. Construction will mobilize small amounts of PAH-contaminated sediments that could be taken up by benthic invertebrates that are forage resources for juvenile salmon. Sediment distribution will be limited to the area well within 300 feet around pile installation/removal and 550 yards of vessel activity, but detectable levels of contaminants may persist for years. While these contaminants persist, they may be mobilized by structure-related scour and taken up by forage resources. Shading and scour from the new breakwater could also reduce the production and diversity of invertebrate organisms that are prey for juvenile PS Chinook salmon. Therefore, the action will cause a long-term minor change in the quality and function of this PBF.

Natural Cover
Increased TSS from construction may temporarily shade small areas of SAV that will recover within months if damaged. The action will also expand a long-standing overwater structure, portions of which may shade eelgrass and macroalgae. Structure-related scour may also reduce reduce adjacent SAV growth into the foreseeable future. Therefore, the action will cause a long-term minor change in the quality and function of this PBF.

Puget Sound / Georgia Basin Bocaccio
Nearshore areas (less than 30 meters, 98 feet deep, relative to MLLW) with substrates such as sand, rock and/or cobble compositions, that also support kelp, provide settlement habitat for juvenile bocaccio. The PBFs for juvenile bocaccio in the action area include juvenile settlement habitats located in the nearshore with substrates such as sand, rock and/or cobble compositions that also support kelp with the following attributes:

- Quantity, quality, and availability of prey species to support individual growth, survival, reproduction, and feeding opportunities; and
- Water quality and sufficient levels of dissolved oxygen to support growth, survival, reproduction, and feeding opportunities.

Quantity, Quality, and Availability of Prey Species

Drilling may injure or increase the risk of predation of forage fish that may occur in the action area. However, the number of individuals injured or killed would be too small to cause population-level effects and be detectable by bocaccio. Construction will mobilize small amounts of PAH-contaminated sediments that could be taken up by benthic invertebrates that are forage resources for juvenile salmon. Sediment distribution will be limited to the area well within 300 feet around pile installation/removal and 550 yards of vessel activity, but detectable levels of contaminants may persist for years. While these contaminants persist, they may be mobilized by structure-related scour and taken up by forage resources. Shading and scour from the new breakwater could reduce the production and diversity of invertebrate organisms that are prey for juvenile bocaccio. Therefore, the action will cause a long-term minor change in the quality and function of this PBF.

Water Quality

The action will eliminate sources of ongoing PAH water contamination through the removal of the existing structure's creosote-treated piles. Construction will briefly mobilize contaminated sediments, and may also very slightly reduce DO in very limited areas. Detectable construction-related effects on water quality are expected to be limited to the area well within 300 feet around pile installation/removal and 550 yards of vessel activity, and are not expected to persist past one or two hours after work stops. However, structure-related scour will episodically increase turbidity and mobilize contaminants in the sediment. Therefore, the action will cause a long-term minor change in the quality and function of this PBF.

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 environmental baseline (Section 2.4).

The current condition of ESA-listed species and designated critical habitat within the action area are described in the Status of the Species and Critical Habitat and the Environmental Baseline sections above. The contribution of non-federal activities to those conditions include past and ongoing shoreline development, vessel activities, and upland urbanization. Those actions were 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 social groups dedicated to restoration and use of natural amenities, such as cultural inspiration and recreational experiences.

NMFS is unaware of any specific future non-federal activities that are reasonably certain to affect the action area. However, NMFS is reasonably certain that future non-federal actions such as the previously mentioned ferry activity and urban development are 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 low-level inputs of non-point source pollutants will likely continue into the future. Recreational and commercial use of nearshore waters within the action area is 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 species in the action area. 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 our assessment of the risk posed to species and critical habitat as a result of implementing the proposed action. In this section, we add the effects of the action (Section 2.5) to the environmental baseline (Section 2.4) and the cumulative effects (Section 2.6), taking into account the status of the species and critical habitat (Section 2.2), to formulate the agency's biological opinion as to whether the proposed action is likely to: (1) Reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing its numbers, reproduction, or distribution; or (2) appreciably diminish the value of designated or proposed critical habitat as a whole for the conservation of the species.

2.7.1 ESA-Listed Species

The species considered in this Opinion have been listed under the ESA, 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. Each 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, as described below, effects on viability parameters of each species are also likely to be negative. In this context we consider the effects of the proposed action's effect on individuals of the listed species at the population scale.

Puget Sound Chinook Salmon

The action area supports PS Chinook salmon adult and juvenile migration, and juvenile rearing. The long-term trend in abundance of the PS Chinook salmon ESU is slightly negative. Reduced or eliminated accessibility to historically important habitat, combined with degraded conditions in available habitat appear to be the greatest threats to the recovery of PS Chinook salmon. Degraded water quality and temperature, degraded nearshore conditions, and impaired passage for migrating fish also continue to impact this species.

The environmental baseline within the action area has been moderately degraded by upland urbanization, shoreline armoring, in-water structures, creosote piles, and maritime activities. However, despite this overall degraded condition, the action area remains supportive of PS Chinook salmon, and provides migratory habitat for adults and juveniles. Eelgrass is present within the action area, which provides forage and cover for rearing and migrating juveniles. The planned work window overlaps with the presence of juvenile PS Chinook salmon. Adults may also be present during construction, but they would be independent of the shoreline.

During construction, very low numbers of juveniles may experience injury or behavioral responses that may increase risk of predation. Propellers and propeller wash from construction-related vessels may also injure, kill, or displace juvenile PS Chinook salmon. For the first few years following construction, out-migrating juveniles may be exposed to ever-decreasing levels of contaminated forage, due to mobilization of small amounts of contaminated sediments during pile removal, vessel activity, and structure-related scour. Consumption of contaminated forage may reduce growth, increase susceptibility to infection, and increase mortality in some individuals. The size and shadow of the new breakwater may increase mortality in juvenile PS Chinook salmon through increased predation and migratory path length.

The proposed action will allow the continued existence and expand the size of an in-water structure that will keep certain habitat conditions at slightly reduced functional levels as compared to undisturbed areas. However, the structure will not cause or worsen any habitat conditions in a manner that would act to limit the recovery of this species. The number of PS Chinook salmon that are likely to be injured or killed by action-related stressors is unknown, but is expected to be very low, and such a small fraction of a returning cohort that it will have no detectable effect on any of the characteristics of a viable salmon population (VSP), abundance, productivity, distribution, or genetic diversity) for the affected population(s). 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, will be too small to cause any population level impacts on PS Chinook salmon. Therefore, the proposed action will not appreciably reduce the likelihood of survival and recovery of this listed species.

Puget Sound / Georgia Basin Rockfish

The action area may support juvenile rearing. No reliable population estimates are available for the DPS, but the best available information indicates that bocaccio were never a predominant segment of the total rockfish abundance in Puget Sound, and suggest that their present-day abundance is likely a fraction of their pre-contemporary fishery abundance. Fishing removals and degraded water quality appear to be the greatest threats to the recovery of the DPS. The environmental baseline within the action area has been moderately degraded by upland urbanization, shoreline armoring, in-water structures, creosote piles, and maritime activities. However, despite this degraded condition, the action area remains supportive of juveniles. Eelgrass is present within the action area, which provides cover and forage.

During construction, very low numbers of juveniles may experience injury or behavioral responses that may increase risk of predation. Propellers and propeller wash from construction-related vessels may also injure, kill, or displace juvenile PS/GB bocaccio. For the first few years following construction, juveniles may be exposed to ever-decreasing levels of contaminated forage, due to mobilization of small amounts of contaminated sediments during pile removal, vessel activity, and structure-related scour. Consumption of contaminated forage may reduce growth, increase susceptibility to infection, and increase mortality in some individuals.

The proposed action will allow the continued existence and expand the size of an in-water structure that will keep certain habitat conditions at slightly reduced functional levels as compared to undisturbed areas. However, the structure will not cause or worsen any habitat conditions in a manner that will act to limit the recovery of this species. 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, will be too small to cause any population level impacts on PS/GB bocaccio. Therefore, the proposed action will not appreciably reduce the likelihood of survival and recovery of this listed species.

2.7.2 Critical Habitat

As described above at Section 2.5.2, the proposed action is likely to adversely affect designated critical habitat for PS Chinook salmon and PS/GB bocaccio.

Chinook Salmon

For PS Chinook salmon critical habitat, past and ongoing anthropogenic activities have diminished the availability and quality of nearshore marine habitats and reduced water quality across the Puget Sound basin. Marine habitat threats include urbanization, wetland draining and conversion, dredging, armoring of shorelines, and marina and port development. Future non-federal actions and climate change are likely to increase and continue acting against the quality of salmonid critical habitat. The intensity of those influences on salmonid habitats is uncertain, as is the degree to which those impacts may be tempered by adoption of more environmentally acceptable land use practices, implementation of non-federal plans that are intended to benefit salmonids, and efforts to address the effects of climate change.

PS Chinook salmon critical habitat in the action area is limited to nearshore marine areas free of obstruction and excessive predation. As described above, the environmental baseline within the action area has been moderately degraded from upland urbanization, shoreline armoring, in-water structures, creosote piles, and maritime activities. However, despite this degraded condition, the action area remains supportive of PS Chinook salmon.

The new breakwater will cause long-term minor effects on the obstruction and predation, water quality, forage, and natural cover. 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, will be too small to cause any detectable long-term negative changes in the quality or functionality of nearshore marine area PBFs in the action area. Therefore, this critical habitat will maintain its current level of functionality, and retain its current ability for PBF to become functionally established, to serve the intended conservation role for PS Chinook salmon.

Bocaccio

For PS/GB bocaccio critical habitat, nearshore critical habitat has been degraded by past and ongoing shoreline development that has altered shoreline substrates, degraded water quality, and reduced eelgrass and kelp habitats in many areas of Puget Sound. Future non-federal actions and climate change are likely to increase and continue acting against the quality of PS/GB bocaccio critical habitat. The intensity of those influences is uncertain, as is the degree to which those impacts may be tempered by adoption of more environmentally acceptable practices, restoration activities, and efforts to address the effects of climate change.

The PBF for PS/GB bocaccio critical habitat in the action area is limited to nearshore settlement habitats with sand, rock, and/or cobble substrates that also support kelp. The site attributes of that PBF that will be affected by the action are limited to prey quantity, quality, and availability, and water quality and sufficient DO to support individual growth, survival, reproduction, and feeding opportunities. As described above, the environmental baseline within the action area has been moderately degraded from upland urbanization, shoreline armoring, in-water structures, creosote piles, and maritime activities. However, despite this degraded condition, the action area remains supportive of PS/GB bocaccio.

The new breakwater would cause long-term minor effects on water quality and the quantity, quality, and availability of prey species. 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, will be too small to cause any detectable long-term negative changes in the quality or functionality of nearshore marine area PBFs in the action area. Therefore, this critical habitat will maintain its current level of functionality, and retain its current ability for PBF to become functionally established, to serve the intended conservation role for PS/GB bocaccio.

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 NMFS' biological opinion that the proposed action is not likely to jeopardize the continued existence of PS

Chinook salmon and PS/GB bocaccio, or destroy or adversely modify PS Chinook salmon and PS/GB bocaccio designated critical habitat.

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). "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, NMFS determined that incidental take is reasonably certain to occur as follows:

Harm of PS Chinook salmon from:

- Exposure to construction-related noise
- Exposure to contaminated forage
- Exposure to structure-related altered migratory behaviors
- Exposure to structure-related predation
- Exposure to construction-related propeller wash

Harm of PS/GB bocaccio from:

- Exposure to construction-related noise
- Exposure to contaminated forage
- Exposure to construction-related propeller wash

The distribution and abundance of fish that occur within an action area are affected by habitat quality, competition, predation, and the interaction of processes that influence genetic, population, and environmental characteristics. These biotic and environmental processes interact in ways that may be random or directional, and may operate across far broader temporal and spatial scales than are affected by the proposed action. Thus, the distribution and abundance of fish within the action area cannot be attributed entirely to habitat conditions, nor can NMFS precisely predict the number of fish that are reasonably certain to be injured or killed if their habitat is modified or degraded by the proposed action.

Therefore, we cannot predict with meaningful accuracy the number of PS Chinook salmon and PS/GB bocaccio that are reasonably certain to be injured or killed by exposure to any of these stressors. Additionally, NMFS knows of no device or practicable technique that would yield reliable counts of individuals that experience these impacts. In such circumstances, NMFS uses the causal link established between the activity and the likely extent and duration of changes in habitat conditions to describe the extent of take as a numerical level of habitat disturbance. The most appropriate surrogates for take are action-related parameters that are directly related to the magnitude of the expected take.

Construction-Related Noise and Propeller Wash
For this action, the timing and duration of work are the best available surrogates for the extent of take of listed species from exposure to construction-related noise and propeller wash. Timing and duration of work are applicable because the planned work windows were selected to reduce the potential for fish presence at the project site. Therefore, working outside of the planned work window and/or working for longer than planned would increase the number of fish likely to be exposed to construction-related impacts that are likely to cause injury or reduce fitness.

For take resulting from noise from construction-related vessels, drilling, and pile extraction and installation, we use the geographic extent of noise as a habitat surrogate. The geographic extent of noise is dependent on duration, pile type, pile size, method of pile extraction/installation. This surrogate is proportional to the amount of take, because we expect an increased number of individuals exposed to project-related noise with increasing geographic extent of the noise.

Construction-Related Contaminated Forage
For increased suspended sediment and PAH exposure, the best available indicator for the extent of take is the extent of visible increased turbidity. Based on past projects (Bloch 2010), the observed extent of turbidity is a reliable indicator of the extent of elevated suspended sediment, and therefore, the extent of exposure of listed species. Because PAHs will be released during activities that increase suspended sediment, the observed extent of turbidity is a reliable indicator of the extent of PAH exposure.

Structure-Related Altered Migratory Behavior and Increased Predation
The size of the new breakwater is the best available surrogate for the extent of take of juvenile PS Chinook salmon from altered migratory behaviors and predation. This is because the size of the shaded area is positively correlated with size of the new breakwater, and the distance juvenile PS Chinook salmon will swim around the structure. As the size increases, the risk of predation increases (deeper water), energetic costs increases (increased migratory distance), and fitness of individuals decreases.

In summary, the extent of take for this action is defined as:

1. PS Chinook salmon:
    - In-water work between August 1 and October 15;
    - Geographic extent of construction-related underwater noise;
    - Geographic extent of visible turbidity; and
    - Size of the new breakwater.

2. PS/GB bocaccio:

- In-water work between August 1 and October 15;
- Geographic extent of construction-related underwater noise; and
- Geographic extent of visible turbidity

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

2.9.2 Effect of the Take

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

2.9.3 Reasonable and Prudent Measures

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

The FHWA shall:

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

2.9.4 Terms and Conditions

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

1) The following terms and conditions implement reasonable and prudent measure 1:
   - i) Require the applicant to maintain and submit construction logs to verify that all take indicators are monitored and reported. The logs should indicate:
     - (1) An in-water work window of August 1 to October 15;
     - (2) Use of a full-depth silt curtain around pile extraction;
     - (3) A visible turbidity plume not to exceed 300 feet from the project site during any portion of the project;
     - (4) Maximum length of the new breakwater not to exceed 123 feet; and
     - (5) The combined duration of vibratory installation, vibratory extraction, and drilling 12-inch timber piles, 24-inch steel piles, 12-inch steel piles, and 12-inch steel H-piles not to exceed:
       - (a) A total of 6 hours per day;
       - (b) A total of 39 days; and
       - (c) A total of 98 hours.

ii) Submit an electronic post-construction report to NMFS within six months of project completion. Send the report to: projectreports.wcr@noaa.gov. Be sure to include the NMFS Tracking number for this project in the subject line: Attn: WCRO-2019-00556.

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).

The FHWA should encourage the applicant to:

1) Use the lowest safe maneuvering speeds and power settings when maneuvering in shallow water close to the shoreline, with the intent to minimize propeller wash.
2) Install clean capping material over substrates where contaminated sediments may settle out after pile installation.

2.11 Reinitiation of Consultation

This concludes formal consultation for the Lummi Ferry Breakwater Project in Lummi Island, Washington.

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

2.12 "Not Likely to Adversely Affect" Determinations

Puget Sound Steelhead

Juvenile PS steelhead primarily emigrate from natal streams in April and May, and appear to move directly out into the ocean to rear, spending little time in the nearshore zone (Goetz et al. 2015). They are not commonly caught on beach seine surveys (Brennan et al. 2004). Therefore, they are extremely unlikely to be present in the action area and be exposed to construction-related effects.

Adult PS steelhead are not nearshore dependent. Adult winter-run PS steelhead typically return to their natal river November through May; summer-run PS steelhead return between April and October. Adult PS steelhead will be large, highly mobile, typically utilize habitat deeper than the

area surrounding the breakwater, and will be migrating past the site in route to their natal streams. Therefore, they are unlikely to accumulate injurious levels of sound energy or be exposed to increased predation. Given the small size of the area of acoustic effect and availability of similar habitat in the surrounding area, any avoidance of the action area will not have a meaningful effect on this species. Therefore, construction-related noise will not affect the fitness or normal behaviors of PS steelhead.
Turbidity would be temporary and at concentrations too low to cause more than temporary, non-injurious effects that, as described in Section 2.5.1, are not likely to adversely affect exposed individuals. As described in Section 2.5.1, only a small amount of sediment will be mobilized by construction-related vessels. This suggests that any impacts on DO will be too small and short-lived to cause detectable effects in exposed fish. Further, it is unlikely that PS steelhead that feed on forage fish would be impacted by contaminated forage, because biomagnification of PAHs does not occur in fish (Suedel et al. 1994).

Construction-related propellers and propeller wash is unlikely to affect adult PS steelhead, because they are unlikely to approach close enough to operating boats to be exposed. In the unlikely event of adult exposure, their increased size and swimming ability suggest that they will swim away from the propeller wash with no detectable effects other than a very brief avoidance behavior.

Adult and juvenile PS steelhead will move quickly through the area and will be relatively large and free from shoreline obligation. Therefore, their migratory pathway is unlikely to be obstructed by the new breakwater or experience an increased risk of predation. Additionally, NMFS expects that in-water light levels at the site that would be attributable to the proposed action would only be minimally detectable and too low to cause meaningful effects in the fitness or normal behaviors of juvenile and adult PS steelhead that might migrate past the breakwater.

Further, the number of forage fish and invertebrates that may be injured or killed by underwater noise, propellers, and scour would be too small to cause detectable effects on their populations in the action area. Therefore, forage reductions would be too small to cause detectable effects on PS steelhead.

Southern Resident Killer Whales and Humpback Whales
Southern Resident killer whales (SRKW) may pass through the action area, but are very unlikely to occur. According to killer whale sighting information from The Whale Museum (2019) from 1990 to 2013, this species has been observed 1 time in the action area, 2 times northwest of the action area, and 4 times southeast of the action area during the proposed project work window (August through October). According to the Orca Network (2019) from 2003 to 2019, this species has been observed 1 time southeast of the action area during the work window. Humpback whales were not observed within or adjacent to the action area. Therefore, the project is extremely unlikely to affect humpback whales.

Vibratory pile driving and drilling have the potential to yield adverse effects to the ESA-listed cetaceans from the generation of underwater sound pressure levels, if those levels exceed established injury thresholds. NMFS revised its Technical Guidance for Assessing the Effects of Anthropogenic Noise on Marine Mammal Hearing in April 2018, which provides threshold for injury and behavioral disturbance for various noise sources. The weighted threshold for permanent hearing threshold shifts (PTS) from non-impulsive noise (i.e., vibratory pile driving, drilling) is 198 dB (re: 1µPa•second) cumulative SEL for mid-frequency cetaceans such as killer whales (NMFS 2018). The threshold for behavioral disruption from continuous noise (e.g., vibratory pile driving) is 120 dB (re: 1µPa) RMS.

The applicant will monitor the boundary of the action area for the presence of cetaceans 30 minutes prior, during, and 30 minutes after vibratory pile driving or drilling activities (see Appendix A). This will include the area where PTS and behavioral disruption could occur. There will be a land-based observer at the northern end of the action area, southern end of the action area, and one in the center of the action area adjacent to the area where PTS could occur. If the monitors observe a cetacean approaching or within the action area, the applicant will cease pile driving or drilling activities until the cetacean leaves the action area or has not been detected within the action area for 30 minutes. Consequently, we do not expect that noise and increased turbidity associated with vibratory pile installation/extraction and drilling would cause injurious effects to marine mammals that would rise to the level of take.

The effects to Chinook salmon will not cause population-level effects that will measurably reduce SRKW forage. Additionally, because the number of juvenile PS Chinook salmon that consume contaminated prey at the site would be very low, and because only a small subset of those individuals may be consumed by SRKW, the action is extremely unlikely to cause detectable levels of contaminants in SRKW.

Southern Resident Killer Whale Critical Habitat
The proposed action is not likely to adversely affect critical habitat that has been designated for SRKW. We designated critical habitat for SRKW on November 29, 2006 (71 FR 69054). Critical habitat for SRKW includes marine waters of PS that are at least 20 feet deep.

The PBFs of SRKW critical habitat in the action area include:

- Water quality to support growth and development;
- Prey species of sufficient quantity, quality, and availability to support individual growth, reproduction and development, as well as overall population growth; and
- Passage conditions to allow for migration, resting, and foraging.

The proposed action will cause ephemeral minor effects on water quality. The presence of detectable levels of contaminants, including suspended sediments, will be ephemeral, infrequent, localized, and of such low concentrations that changes in water quality will be insignificant.

As discussed above, the proposed action will cause ephemeral minor effects on prey. The effects to Chinook salmon will not cause population-level effects that will measurably reduce the quantity and availability of SRKW forage. Because the number of juvenile PS Chinook salmon that consume contaminated prey at the site would be very low, and because only a small subset of those individuals may be consumed by SRKW, the action is extremely unlikely to reduce the quality of in SRKW forage. Therefore, effects to SRKW prey will be insignificant.

The marine mammal monitoring plan (Appendix A) would ensure that construction-related noise does not disturb SRKW passage through the action area. Therefore, the proposed action is not likely to adversely affect SRKW their critical habitat

Therefore, the proposed action is not likely to adversely affect PS steelhead, humpback whales, or SRKW 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 NMFS on all actions or proposed actions that may adversely affect EFH. The MSA (section 3) defines EFH as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." Adverse effect means any impact that reduces quality or quantity of EFH, and may include direct or indirect physical, chemical, or biological alteration of the waters or substrate and loss of (or injury to) benthic organisms, prey species and their habitat, and other ecosystem components, if such modifications reduce the quality or quantity of EFH. Adverse effects on EFH may result from actions occurring within EFH or outside of it and may include site-specific or EFH-wide impacts, including individual, cumulative, or synergistic consequences of actions (50 CFR 600.810). Section 305(b) also requires NMFS to recommend measures that can be taken by the action agency to conserve EFH.

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

3.1 Essential Fish Habitat Affected by the Project

The proposed action and action area for this consultation are described in Sections 1 and 2 of this document. The action area includes areas designated as EFH for various life-history stages of Pacific Coast groundfish (PFMC 2005), coastal pelagic species (PFMC 1998), and Pacific Coast salmon (PFMC 2014). The action area is designated as a habitat area of particular concern (HAPC) for seagrass.

3.2 Adverse Effects on Essential Fish Habitat

The ESA portion of this document describes the adverse effects of this proposed action on ESA-listed species and critical habitat, and is relevant to the effects on EFH for Pacific coast groundfish, coastal pelagic species, and Pacific Coast salmon. Based on the analysis of effects presented in Section 2.5, the proposed action will cause small-scale adverse effects on this EFH through direct or indirect physical, chemical, or biological alteration of the water or substrate, and through alteration of benthic communities, and the reduction in prey availability. Therefore, we have determined that the proposed action would adversely affect the EFH identified above.

3.3 Essential Fish Habitat Conservation Recommendations

Fully implementing these EFH conservation recommendations would protect, by avoiding or minimizing the adverse effects described in section 3.2, above, approximately 0.09 acres of designated EFH for Pacific coast groundfish, coastal pelagic species, and Pacific Coast salmon.

To reduce adverse alteration of the physical, chemical, or biological characteristics of the water and substrates and available prey,

1) The FHWA shall require the applicant to implement the project and associated conservation measures as described in Section 1.3 of this Opinion, particularly:
    i) Install a full-depth silt curtain around pile extraction.
    ii) Limit vibratory pile removal to vibratory extraction and/or simple pull techniques (no water jetting, no clamshell excavation).
    iii) Require that contractors and tugboat operators adjust work practices to ensure that turbidity does not exceed 300 feet from the project site, and to halt work should the visible turbidity plume approach and that range.

To reduce adverse alteration of benthic communities and reduction in prey availability,

2) The FHWA shall require the applicant to implement the project and associated conservation measures as described in Section 1.3 of this Opinion, particularly:
    i) Ensure temporary piles are located outside of eelgrass.
    ii) Ensure that barges or other structures do not ground out on the bottom.
    iii) Limit the amount of time barges are positioned in one area over eelgrass to three days.
    iv) Install ridge caps with bird spikes on top of the piles to minimize predation of prey species.

3.4 Statutory Response Requirement

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

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

3.5 Supplemental Consultation

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

4. DATA QUALITY ACT DOCUMENTATION AND PRE-DISSEMINATION REVIEW

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

4.1 Utility

Utility principally refers to ensuring that the information contained in this consultation is helpful, serviceable, and beneficial to the intended users. The intended user of this opinion is the FHWA. Other interested users could include WSDOT, tribes, and the operators and users of the ferry terminal and other ferry terminals. Individual copies of this opinion were provided to the FHWA. The document will be available within two weeks at the NOAA Library Institutional Repository (https://repository.library.noaa.gov/welcome). The format and naming adheres to conventional standards for style.

4.2 Integrity

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

4.3 Objectivity

Information Product Category: Natural Resource Plan

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

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

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

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

5. REFERENCES

Abatzoglou, J. T., Rupp, D. E., and Mote, P. W. (2014). Seasonal climate variability and change in the Pacific Northwest of the United States. *Journal of Climate, 27*(5), 2125-2142. doi:https://doi.org/10.1175/JCLI-D-13-00218.1

Anderson, J. J., Gurarie, E., and Zabel, R. W. (2005). Mean free-path length theory of predator–prey interactions: Application to juvenile salmon migration. *Ecological Modelling, 186*(2), 196-211. doi:10.1016/j.ecolmodel.2005.01.014

Bickel, S. L., Hammond, J. D. M., and Tang, K. W. (2011). Boat-generated turbulence as a potential source of mortality among copepods. *Journal of Experimental Marine Biology and Ecology, 401*, 105-109. doi:https://doi.org/10.1016/j.jembe.2011.02.038

Bloch, P. (2010). *SR 520 Test Pile Turbidity Monitoring Technical Memorandum*. Retrieved from Olympia, Washington:

Boese, B. L., Kaldy, J. E., Clinton, P. J., Eldridge, P. M., and Folger, C. L. (2009). Recolonization of intertidal *Zostera marina* L. (eelgrass) following experimental shoot removal. *Journal of Experimental Marine Biology and Ecology, 374*(1), 69-77. doi:https://doi.org/10.1016/j.jembe.2009.04.011

Brennan, J. S., Higgins, K. F., Cordell, J. R., and Stamatiou, V. A. (2004). *Juvenile salmon composition, timing, distribution, and diet in marine nearshore waters of central Puget Sound in 2001-2002*. Retrieved from King County Department of Natural Resources and Parks, Seattle, WA: https://your.kingcounty.gov/dnrp/library/2004/kcr1658/nearshore-part1.pdf

Caltrans. (2015). *Technical guidance for assessment and mitigation of the hydroacoustic effects of pile driving on fish* (CTHWANP-RT-15-306.01.01). Retrieved from Sacramento, California: http://www.dot.ca.gov/hq/env/bio/files/bio_tech_guidance_hydroacoustic_effects_110215.pdf

Celedonia, M. T., Tabor, R. A., Sanders, S., Damm, S., Lantz, D. W., Lee, T. M., Li, Z., Pratt, J.-M., Price, B. E., and Seyda, L. (2008a). *Movement and habitat use of Chinook salmon smolts, northern pikeminnow, and smallmouth bass near the SR 520 Bridge: 2007 acoustic tracking study*. Retrieved from Lacy, Washington: https://www.wsdot.wa.gov/research/reports/fullreports/694.1.pdf

Celedonia, M. T., Tabor, R. A., Sanders, S., Lantz, D. W., and Grettenberger, I. (2008b). *Movement and habitat use of Chinook salmon smolts and two predatory fishes in Lake Washington and the Lake Washington ship canal: 2004-2005 acoustric tracking studies*. Retrieved from Lacey, Washington: https://www.fws.gov/wafwo/fisheries/Publications/2004_2005%20Acoustic%20Final%20Report.pdf

Codarin, A., Wysocki, L. E., Ladich, F., and Picciulin, M. (2009). Effects of ambient and boat noise on hearing and communication in three fish species living in a marine protected area (Miramare, Italy). *Marine Pollution Bulletin, 58*, 1880-1887. doi:https://doi.org/10.1016/j.marpolbul.2009.07.011

Crozier, L. G., Hendry, A. P., Lawson, P. W., Quinn, T. P., Mantua, N. J., Battin, J., Shaw, R. G., and Huey, R. B. (2008). Potential responses to climate change in organisms with complex life histories: evolution and plasticity in Pacific salmon. *Evolutionary Applications, 1*(2), 252-270. doi:10.1111/j.1752-4571.2008.00033.x

Crozier, L. G., Scheuerell, M. D., and Zabel, E. W. (2011). Using time series analysis to characterize evolutionary and plastic responses to environmental change: A case study of a shift toward earlier migration date in sockeye salmon. *The American Naturalist, 178*(6), 755-773. doi:10.1086/662669

Dolat, S. W. (1997). *Acoustic measurements during the Baldwin Bridge demolition*. Retrieved from Waterford, CT:

Dominguez, F., Rivera, E., Lettenmaier, D. P., and Castro, C. L. (2012). Changes in winter precipitation extremes for the western United States under a warmer climate as simulated by regional climate models. *Geophysical Research Letters, 39*(5). doi:https://doi.org/10.1029/2011GL050762

Doney, S. C., Ruckelshaus, M., Duffy, J. E., Barry, J. P., Chan, F., English, C. A., Galindo, H. M., Grebmeier, J. M., Hollowed, A. B., Knowlton, N., Polovina, J., Rabalais, N. N., Sydeman, W. J., and Talley, L. D. (2012). Climate Change Impacts on Marine Ecosystems. *Annual Review of Marine Science, 4*(11-37). doi:https://doi.org/10.1146/annurev-marine-041911-111611

Duncan, A. J., McCauley, R. D., Parnum, I., and Salgado-Kent, C. (2010). *Measurement and modelling of underwater noise from pile driving*. Retrieved from Sydney, Australia: https://www.acoustics.asn.au/conference_proceedings/ICA2010/cdrom-ICA2010/papers/p26.pdf

Ecology, W. S. D. o. (2018). Washington State Coastal Atlas Map: Assessed sediments and assessed waters, Category 5 - 303(d). Retrieved from https://fortress.wa.gov/ecy/coastalatlas/tools/Map.aspx

Enger, P. S., Karlsen, H. E., Knudsen, F. R., and Sand, O. (1993). Detection and reaction of fish to infrasound. *ICES Marine Science Symposia, 196*, 108-112.

ESTCP, E. S. T. C. P. (2016). *Evaluation of resuspension from propeller wash in DoD harbors*. (ER-201031). San Diego, CA: SPAWARSYSCEN Pacific Retrieved from https://apps.dtic.mil/dtic/tr/fulltext/u2/1028959.pdf

Evans, M., Fazakas, K., and Keating, J. (2009). Creosote contamination in sediments of the Grey Owl Marina in Prince Albert National Park, Saskatchewan, Canada. *Water Air Soil Pollution, 201*, 161-184. doi:https://doi.org/10.1007/s11270-008-9935-1

Feely, R. A., Klinger, T., Newton, J. A., and Chadsey, M. (2012). *Scientific summary of ocean acidification in Washington state marine waters*. (Special Report). Retrieved from https://pmel.noaa.gov/co2/files/wa_shellfish_initiative_blue_ribbon_panel_oa_11-27-2012.pdf

Fisheries Hydroacoustic Working Group. (2008). *Agreement in principle for interim criteria for injury to fish from pile driving activities*. Retrieved from https://www.wsdot.wa.gov/sites/default/files/2018/01/17/ENV-FW-BA_InterimCriteriaAgree.pdf

Fresh, K. L. (2006). *Juvenile Pacific Salmon in Puget Sound*. Retrieved from http://www.pugetsoundnearshore.org/technical_papers/juv_salmon.pdf

Glick, P., Clough, J., and Nunley, B. (2007). Sea-Level Rise and Coastal Habitats in the Pacific Northwest: An analysis for Puget Sound, southwestern Washington, and northwestern Oregon. from National Wildlife Federation https://www.nwf.org/~/media/PDFs/Water/200707_PacificNWSeaLevelRise_Report.ashx

Goetz, F. A., Jeanes, E., Moore, M. E., and Quinn, T. P. (2015). Comparative migratory behavior and survival of wild and hatchery steelhead (*Oncorhynchus mykiss*) smolts in riverine, estuarine, and marine habitats of Puget Sound, Washington. *Environmental Biology of Fishes, 98*(1), 357-375. doi:http://dx.doi.org/10.1007/s10641-014-0266-3

Goode, J. R., Buffington, J. M., Tonina, D., Isaak, D. J., Thurow, R. F., Wenger, S., Nagel, D., Luce, C., Tetzlaff, D., and Soulsby, C. (2013). Potential effects of climate change on streambed scour and risks to salmonid survival in snow-dominated mountain basins. *Hydrological Processes, 27*(5), 750-765. doi:https://doi.org/10.1002/hyp.9728

Greene, C., and Godersky, A. (2012). *Larval Rockfish in Puget Sound surface waters*. Retrieved from https://www.nws.usace.army.mil/Portals/27/docs/civilworks/dredging/Greene%20and%20Godersky%20Larval%20Rockfish%20in%20Puget%20Sound%20final%20report.pdf

Hellou, J., and Payne, J. F. (1986). Effect of petroleum hydrocarbons on the biliary bile acid composition of rainbow trout (*Salmo gairdneri*). *Comparative Biochemistry and Physiology Part C: Comparative Pharmacology, 84*(2), 257–261. doi:https://doi.org/10.1016/0742-8413(86)90091-5

Hicks, B. J., Hall, J. D., Bisson, P. A., and Sedell, J. R. (1991). Responses of salmonids to habitat change. In W. R. Meehan (Ed.), *Influences of Forest and Rangeland Management on Salmonid Habitat: American Fisheries Society Special Publication* (Vol. 19, pp. 483-518). Bethesda, Maryland: American Fisheries Society.

Illingworth & Rodkin, I. (2017). *Final report pile-driving noise measurements at Atlantic fleet naval installations: 28 May 2013 - 28 April 2016*. Retrieved from Petaluma, California: https://www.navymarinespeciesmonitoring.us/files/4814/9089/8563/Pile-driving_Noise_Measurements_Final_Report_12Jan2017.pdf

IPCC, I. P. o. C. C. (2014). *Climate Change 2014: Synthesis Report*. Retrieved from Geneva, Switzerland: http://www.ipcc.ch/pdf/assessment-report/ar5/syr/SYR_AR5_FINAL_full_wcover.pdf

Isaak, D. J., Wollrab, S., Horan, D., and Chandler, G. (2012). Climate change effects on stream and river temperatures across the northwest US from 1980–2009 and implications for salmonid fishes. *Climatic Change, 113*(2), 499-524. doi:10.1007/s10584-011-0326-z

ISAB, I. S. A. B. (2007). *Climate change impacts on Columbia River Basin fish and wildlife*. Retrieved from Portland, Oregon: https://www.nwcouncil.org/fish-and-wildlife/fw-independent-advisory-committees/independent-scientific-advisory-board/climate-change-impacts-on-columbia-river-basin-fish-and-wildlife

Karrow, N., Boermans, H. J., Dixon, D. G., Hontella, A., Soloman, K. R., White, J. J., and Bols, N. C. (1999). Characterizing the immunotoxicity of creosote to rainbow trout (*Oncorhynchus mykiss*): A microcosm study. *Aquatic Toxicology, 45*, 223-239.

Kemp, P. S., Gessel, M. H., and Williams, J. G. (2005). Seaward migrating subyearling Chinook salmon avoid overhead cover. *Journal of Fish Biology, 67*. doi:https://doi.org/10.1111/j.0022-1112.2005.00833.x

Killgore, K. J., Miranda, L. E., Murphy, C. E., Wolff, D. M., Hoover, J. J., Keevin, T. M., Maynord, S. T., and Cornish, M. A. (2011). Fish entrainment rates through towboat propellers in the upper Mississippi and Illinois Rivers. *Transactions of the American Fisheries Society, 140*(3), 570-581. doi:https://doi.org/10.1080/00028487.2011.581977

Knudsen, F. R., Schreck, C. B., Knapp, S. M., Enger, P. S., and Sand, O. (1997). Infrasound produces flight and avoidance responses in Pacific juvenile salmonids. *Journal of Fish Biology, 51*, 824-829. doi:https://doi.org/10.1111/j.1095-8649.1997.tb02002.x

Kunkel, K. E., Stevens, L. E., Stevens, S. E., Sun, L., Janssen, E., Wuebbles, D., Redmond, K. T., and Dobson, J. G. (2013). *Regional Climate Trends and Scenarios for the U.S. National Climate Assessment: Part 6*. (NESDIS 142-6). Washington, D.C. Retrieved from https://scenarios.globalchange.gov/sites/default/files/NOAA_NESDIS_Tech_Report_142-6-Climate_of_the_Northwest_U.S_0.pdf

Landrum, P. F., Eadie, B. J., Faust, W. R., Morehead, N. R., and McCormick, M. J. (1984). *Role of sediment in the bioaccumulation of benzo(a)pyrene by the amphipod, Pontoporeia hoyi*. Columbus, Ohio: Battelle Press.

Landrum, P. F., and Scavia, D. (1983). Influence of sediment on anthracene uptake, depuration, and biotransformation by the amphipod *Hyalella azteca*. *Canadian Journal of Fisheries and Aquatic Sciences, 40*, 298-305. doi:https://doi.org/10.1139/f83-044

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

Lee, R., and Dobbs, G. (1972). Uptake, metabolism and discharge of polycyclic aromatic hydrocarbons by marine fish. *Marine Biology, 17*, 201-208. doi:https://doi.org/10.1007/BF00366294

Love, M. S., Yoklavich, M., and Thorsteinson, L. (2002). The rockfishes of the northeast Pacific.

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

Mantua, N., Tohver, I., and Hamlet, A. (2010). Climate change impacts on streamflow extremes and summertime stream temperature and their possible consequences for freshwater salmon habitat in Washington State. *Climatic Change, 102*(1), 187-223. doi:https://doi.org/10.1007/s10584-010-9845-2

McCabe, G. T., Hinton, S. A., and Emmet, R. L. (1998). *Benthic invertebrates and sediment characteristics in a shallow navigation channel of the lower Columbia River, before and after dredging*. Retrieved from Seattle, WA: https://research.libraries.wsu.edu/xmlui/bitstream/handle/2376/1220/v72%20p116%20McCabe%20et%20al.PDF?sequence=1&isAllowed=y

McCain, B., Malins, D. C., Krahn, M. M., Brown, D. W., Gronlund, W. D., Moore, L. K., and Chan, S.-L. (1990). Uptake of aromatic and chlorinated hydrocarbons by juvenile Chinook salmon (*Oncorhynchus tshawytscha*) in an urban estuary. *Archives of Environmental Contamination and Toxicology, 19*, 10-16. doi:https://doi.org/10.1007/BF01059807

McMahon, T. E., and Hartman, G. F. (1989). Influence of cover complexity and current velocity on winter habitat use by juvenile coho salmon (*Oncorhynchus kisutch*). *Canadian Journal of Fisheries and Aquatic Sciences, 46*(9), 1551-1557. doi:https://doi.org/10.1139/f89-197

Meador, J. P., Sommers, F. C., Ylitalo, G. M., and Sloan, C. A. (2006). Altered growth and related physiological responses in juvenile Chinook salmon (*Oncorhynchus tshawytscha*) from dietary exposure to polycyclic aromatic hydrocarbons (PAHs). *Canadian Journal of Fisheries and Aquatic Sciences, 63*, 2364-2376. doi:https://doi.org/10.1139/f06-127

Meyer, J. L., Sale, M. J., Mulholland, P. J., and Poff, N. L. (1999). Impacts of climate change on aquatic ecosystem functioning and health. *JAWRA Journal of the American Water Resources Association, 35*(6), 1373-1386. doi:10.1111/j.1752-1688.1999.tb04222.x

Moore, M. E., Berejikian, B. A., and Tezak, E. P. (2013). A floating bridge disrupts seaward migration and increases mortality of steelhead smolts in Hood Canal, Washington State. *PLoS One, 8*(9). doi:https://doi.org/10.1371/journal.pone.0073427

Morton, J. W. (1976). *Ecological effects of dredging and dredge spoil disposal: a literature review*. Retrieved from Washington, DC: https://babel.hathitrust.org/cgi/pt?id=mdp.39015086512640;view=1up;seq=7

Mote, P. W., Abatzoglou, J. T., and Kunkel, K. E. (2013). Climate: Variability and Change in the Past and the Future. In P. W. M. M.M. Dalton, and A.K. Snover (Ed.), *Climate Change in the Northwest: Implications for Our Landscapes, Waters, and Communities*. Washington D.C.: Island Press.

Mote, P. W., Rupp, D. E., Li, S., Sharp, D. J., Otto, F., Uhe, P. F., Xiao, M., Lettenmaier, D. P., Cullen, H., and Allen, M. R. (2016). Perspectives on the cause of exceptionally low 2015 snowpack in the western United States. *Geophysical Research Letters, 43*, 10980-11098. doi:https://doi.org/10.1002/2016GL069965

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

Mueller, G. (1980). Effects of Recreational River Traffic on Nest Defense by Longear Sunfish. *Transactions of the American Fisheries Society, 109*(2), 248-251. doi:10.1577/1548-8659(1980)109<248:EORRTO>2.0.CO;2

Munsch, S. H., Cordell, J. R., Toft, J. D., and Morgan, E. E. (2014). Effects of seawalls and piers on fish assemblages and juvenile salmon feeding behavior. *North American Journal of Fisheries Management, 34*(4), 814-827. doi:http://dx.doi.org/10.1080/02755947.2014.910579

Nedwell, J., and Brooker, A. (2008). *Measurement and assessment of background underwater noise and its comparison with noise from pin pile drilling operations during installation of the SeaGen tidal turbine device, Strangford Lough*. Retrieved from https://tethys.pnnl.gov/sites/default/files/publications/Nedwell-Brooker-2008.pdf

Neff, J. M. (1982). *Accumulation and release of polycyclic aromatic hydrocarbons from water, food, and sediment by marine animals*. (600/9-82-013). N.L. Richards and B.L. Jackson (eds.) Retrieved from https://nepis.epa.gov/Exe/ZyPDF.cgi/9101R2QQ.PDF?Dockey=9101R2QQ.PDF

Neff, J. M., Cox, B. A., Dixit, D., and Anderson, J. W. (1976). Accumulation and release of petroleum-derived aromatic hydrocarbons by four species of marine animals. *Marine Biology, 38*(3), 279-289. doi:https://doi.org/10.1007/BF00388940

Neo, Y. Y., Seitz, J., Kastelein, R. A., Winter, H. V., Cate, C., and Slabbekoorn, H. (2014). Temporal structure of sound affects behavioural recovery from noise impact in European seabass. *Biological Conservation, 178*, 65-73. doi:https://doi.org/10.1016/j.biocon.2014.07.012

Newcombe, C. P., and Jensen, J. O. (1996). Channel suspended sediment and fisheries: a synthesis for quantitative assessment of risk and impact. *North American Journal of Fisheries Management, 16*, 693-727.

Nightingale, B., and Simenstad, C. A. (2001). *Overwater Structures: Marine Issues*. Retrieved from Washington State Transportation Center: https://wdfw.wa.gov/publications/00051/wdfw00051.pdf

Niimi, A. J., and Dookhran, G. P. (1989). Dietary absorption efficiencies and elimination rates of polycyclic aromatic hydrocarbons (PAHs) in rainbow trout (*Salmo gairdneri*). *Environmental Toxicology and Chemistry, 8*, 719-722. doi:https://doi.org/10.1002/etc.5620080809

Niimi, A. J., and Palazzo, V. (1986). Biological half-lives of eight polycyclic aromatic hydrocarbons (PAHs) in rainbow trout (*Salmo gairdneri*). *Water Research, 20*, 503-507. doi:https://doi.org/10.1016/0043-1354(86)90200-9

NMFS. (2006). *Final supplement to the Shared Strategy's Puget Sound salmon recovery plan*. Seattle, Washington Retrieved from https://www.westcoast.fisheries.noaa.gov/publications/recovery_planning/salmon_steelhead/domains/puget_sound/chinook/ps-supplement.pdf

NMFS. (2016). *Five year status review: summary and evaluation, yelloweye rockfish (Sebastes ruberrimus), canary rockfish (Sebastes pinniger), and bocaccio (Sebastes paucispinis) of the Puget Sound/Georgia Basin*. Seattle, Washington Retrieved from https://www.westcoast.fisheries.noaa.gov/publications/protected_species/other/rockfish/5.5.2016_5yr_review_report_rockfish.pdf

NMFS. (2017a). *Endangered Species Act recovery plan for the Southern Distinct Population Segment of eulachon (Thaleichthys pacificus)*. Portland, OR Retrieved from https://repository.library.noaa.gov/view/noaa/15989

NMFS. (2017b). *Rockfish recovery plan: Puget Sound/Georgia Basin yelloweye rockfish (Sebastes ruberrimus) and bocaccio (Sebastes paucispinis)*. Seattle, Washington Retrieved from https://www.westcoast.fisheries.noaa.gov/publications/protected_species/other/rockfish/yelloweye_rockfish_and_bocaccio_recovery_plan.pdf

NMFS. (2017c). Turbidity table. Retrieved from https://www.greateratlantic.fisheries.noaa.gov/protected/section7/guidance/consultation/turbiditytablenew.html

NMFS. (2018). *Revision to technical guidance for assessing the effects of anthropogenic sound on marine mammal hearings (version 2.0): underwater thresholds for onset of permanent and temporary threshold shifts*. Silver Spring, Maryland Retrieved from https://www.fisheries.noaa.gov/national/marine-mammal-protection/marine-mammal-acoustic-technical-guidance

NWFSC, N. F. S. C. (2015). *Status review update for Pacific salmon and steelhead listed under the Endangered Species Act: Pacific Northwest*. Retrieved from https://www.nwfsc.noaa.gov/assets/11/8623_03072016_124156_Ford-NWSalmonBioStatusReviewUpdate-Dec%2021-2015%20v2.pdf

Ono, K., Simenstad, C. A., Toft, J. D., Southard, S. L., Sobocinski, K. L., and Borde, A. (2010). *Assessing and mitigating dock shading impacts on the behavior of juvenile pacific salmon (Oncorhyncus spp.): Can artificial light mitigate the effects*. Retrieved from https://www.wsdot.wa.gov/research/reports/fullreports/755.1.pdf

Orca Network. (2019). Orca Network sightings archives. Retrieved from http://www.orcanetwork.org/Archives/index.php?categories_file=Sightings%20Archives%20Home

Palsson, W. A., Tsou, T., Bargmann, G. G., Buckley, R. M., West, J. E., Mills, M. L., Cheng, Y. W., and Pacunski, R. E. (2009). *The biology and assessment of rockfishes in Puget Sound*. Retrieved from https://wdfw.wa.gov/publications/00926/wdfw00926.pdf

Parametrix. (2011). t. A. N. Parametrix, Suite 1800, Bellevue, Washington 98004-5571.

Penttila, D. (2007). *Marine forage fishes in Puget Sound* (Puget Sound Partnership Report No. 2007-3). Retrieved from Seattle, WA: http://www.pugetsoundnearshore.org/technical_papers/marine_fish.pdf

PFMC, P. F. M. C. (1998). *Description and identification of essential fish habitat for the Coastal Pelagic Species Fishery Management Plan*. Retrieved from Portland, Oregon: http://www.pcouncil.org/wp-content/uploads/cpsa8_apdx_d.pdf

PFMC, P. F. M. C. (2005). *Amendment 18 (bycatch mitigation program), Amendment 19 (essential fish habitat) to the Pacific Coast Groundfish Fishery Management Plan for the California, Oregon, and Washington groundfish fishery*. Retrieved from Portland, Oregon: https://www.pcouncil.org/wp-content/uploads/A18-19Final.pdf

PFMC, P. F. M. C. (2014). *Appendix A to the Pacific Coast Salmon Fishery Management Plan, as modified by Amendment 18 to the Pacific Coast Salmon Plan: Identification and description of essential fish habitat, adverse impacts, and recommended conservation measures for salmon*. Retrieved from Portland, Oregon: https://www.westcoast.fisheries.noaa.gov/publications/habitat/essential_fish_habitat/salmon_efh_appendix_a_final_september-25_2014__2_.pdf

Picciulin, M., Sebastianutto, L., Codarin, A., Farina, A., and Ferrero, E. A. (2010). In situ behavioural responses to boat noise exposure of Gobius cruentatus (Gmelin, 1789; fam. Gobiidae) and Chromis chromis (Linnaeus, 1758; fam. Pomacentridae) living in a Marine Protected Area. *Journal of Experimental Marine Biology and Ecology, 386*(1-2), 125-132. doi:10.1016/j.jembe.2010.02.012

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

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

Rice, C. A., Greene, C. M., Moran, P., Teel, D. J., Kuligowski, D. R., Reisenbichler, R. R., Beamer, E. M., Karr, J. R., and Fresh, K. L. (2011). Abundance, stock origin, and length of marked and unmarked juvenile Chinook salmon in the surface waters of greater Puget Sound. *Transactions of the American Fisheries Society, 140*(1), 170-189.

Romberg, P. (2005). *Recontamination Sources at Three Sediment Caps in Seattle*. Retrieved from https://your.kingcounty.gov/dnrp/library/wastewater/sedman/Denny/Denny_200506.pdf

Roubal, W. T., Collier, T. K., and Malins, D. C. (1977). Accumulation and metabolism of carbon-14 labeled benzene, naphthalene, and anthracene by young Coho salmon (*Oncorhynchus kisutch*). *Archives of Environmental Contamination and Toxicology, 5*, 513-529. doi:https://doi.org/10.1007/BF02220929

Sand, O., Enger, P. S., Karlsen, H. E., Knudsen, F., and Kvernstuen, T. (2000). Avoidance responses to infrasound in downstream migrating European silver eels, *Anguilla anguilla*. *Environmental Biology of Fishes, 57*, 327-336. doi:https://doi.org/10.1023/A:1007575426155

Scheuerell, M. D., and Williams, J. G. (2005). Forecasting climate-induced changes in the survival of Snake River spring/summer Chinook salmon (*Oncorhynchus tshawytscha*). *Fisheries Oceanography, 14*(6), 448-457. doi:http://dx.doi.org/10.1111/j.1365-2419.2005.00346.x

Sebastianutto, L., Picciulin, M., Costantini, M., and Ferrero, E. A. (2011). How boat noise affects an ecologically crucial behaviour: the case of territoriality in Gobius cruentatus (Gobiidae). *Environmental Biology of Fishes, 92*(2), 207-215. doi:10.1007/s10641-011-9834-y

Simenstad, C. A., Nightingale, B. J., Thom, R. M., and Shreffler, D. K. (1999). *Impacts of ferry terminals on juvenile salmon migrating along Puget Sound shorelines*. Retrieved from Olympia, Washington: http://depts.washington.edu/trac/bulkdisk/pdf/272.1.pdf

Simpson, S. D., Radford, A. N., Nedelec, S. L., Ferrari, M. C. O., Chivers, D. P., McCormick, M. I., and Meekan, M. G. (2016). Anthropogenic noise increases fish mortality by predation. *Nature Communications, 7*, 10544. doi:10.1038/ncomms10544

Smith, P. T. (2008). Risks to human health and estuarine ecology posed by pulling out creosote-treated timber on oyster farms. *Aquatic Toxicology, 86*(2), 287-298. doi:https://doi.org/10.1016/j.aquatox.2007.11.009

Southard, S. L., Thom, R. M., Williams, G. D., Toft, T. J. D., May, C. W., McMichael, G. A., Vucelick, J. A., Newell, J. T., and Southard, J. A. (2006). *Impacts of ferry terminals on juvenile salmon movement along Puget Sound shorelines*. Retrieved from https://rosap.ntl.bts.gov/view/dot/16233/dot_16233_DS1.pdf

SSDC, S. S. D. C. (2007). *Puget Sound salmon recovery plan*. Retrieved from https://www.westcoast.fisheries.noaa.gov/publications/recovery_planning/salmon_steelhead/domains/puget_sound/chinook/pugetsoundchinookrecoveryplan_wo_exec_summary.pdf

Stadler, J. H., and Woodbury, D. P. (2009). *Assessing the effects to fishes from pile driving: Application of new hydroacoustic criteria*. Paper presented at the inter-noise 2009, Ottawa, CA. ftp://ftp.odot.state.or.us/techserv/geo-environmental/Biology/Hydroacoustic/References/Literature%20references/Stadler%20and%20Woodbury%202009.%20%20Assessing%20the%20effects%20to%20fishes%20from%20pile%20driving.pdf

Statham, C. N., Elcombe, C. R., Szyjka, S. P., and Lech, J. J. (1978). Effect of polycyclic aromatic hydrocarbons on hepatic, microsomal enzymes and disposition on methylnaphthalene in rainbow trout *in vivo*. *Xenobiotica, 8*(2), 65-71. doi:https://doi.org/10.3109/00498257809060385

Suedel, B. C., Boraczek, J. A., Peddicord, R. K., Clifford, P. A., and Dillon, T. M. (1994). Trophic transfer and biomagnification potential of contaminants in aquatic ecosystems. *Reviews of Environmental Contamination and Toxicology, 136*, 22-89. doi:10.1007/978-1-4612-2656-7_2

Sunda, W. G., and Cai, W. J. (2012). Eutrophication induced CO2-acidification of subsurface coastal waters: interactive effects of temperature, salinity, and atmospheric pCO2. *Environmental Science & Technology, 46*(19), 10651-10659. doi:10.1021/es300626f

Tague, C. L., Choate, J. S., and Grant, G. (2013). Parameterizing sub-surface drainage with geology to improve modeling streamflow responses to climate in data limited environments. *Hydrology and Earth System Sciences, 17*(1), 341-354. doi:https://doi.org/10.5194/hess-17-341-2013

The Whale Museum. (2019). Southern Resident killer whale sighting compilation 1948-2018. In.

Tillmann, P., and Siemann, D. (2011). *Climate Change Effects and Adaptation Approaches in Marine and Coastal Ecosystems of the North Pacific Landscape Conservation Cooperative Region*. Retrieved from https://www.nwf.org/~/media/PDFs/Global-Warming/2014/Marine-Report/NPLCC_Marine_Climate-Effects_Final.pdf

Varanasi, U., Casillas, E., Arkoosh, M. R., Hom, T., Misitano, D. A., Brown, D. W., Chan, S. L., Collier, T. K., McCain, B. B., and Stein, J. E. (1993). *Contaminant exposure and associated biological effects in juvenile Chinook salmon (Oncorhynchus tshawytscha) from urban and nonurban estuaries of Puget Sound*. (NMFS-NWFSC-8). Seattle, WA: NMFS NFSC Retrieved from https://www.nwfsc.noaa.gov/publications/scipubs/techmemos/tm8/tm8.html

Varanasi, U., Stein, J. E., and Nishimoto, M. (1989). Biotransformation and disposition of polycyclic aromatic hydrocarbons in fish. In U. Varanasi (Ed.), *Metabolism of Polycyclic Aromatic Hydrocarbons in the Aquatic Environment* (pp. 93-149). Boca Raton, Florida: CRC Press.

Veirs, S., Veirs, V., and Wood, J. D. (2016). Ship noise extends to frequencies used for echolocation by endangered killer whales. *PeerJ, 4*, e1657. doi:https://doi.org/10.7717/peerj.1657

Wainwright, T. C., and Weitkamp, L. A. (2013). Effects of climate change on Oregon Coast coho salmon: habitat and life-cycle interactions. *Northwest Science, 87*(3), 219-242. doi:https://doi.org/10.3955/046.087.0305

WDFW. (2018). Forage Fish Spawning Map - Washington State. Retrieved from https://wdfw.wa.gov/conservation/research/projects/marine_beach_spawning/

Werme, C., Hunt, J., Beller, E., Cayce, K., Klatt, M., Melwani, A., Polson, E., and Grossinger, R. (2010). *Removal of Creosote-Treated Pilings and Structures from San Francisco Bay*. Retrieved from Oakland, California: https://www.sfei.org/sites/default/files/ReportNo605_Creosote_Dec2010_finalJan13.pdf

Whatcom County. (2019). Lummi Island Ferry Schedule. Retrieved from http://www.co.whatcom.wa.us/562/Ferry-Schedule

Willette, T. M. (2001). Foraging behaviour of juvenile pink salmon (*Oncorhynchus gorbuscha*) and size-dependent predation risk. *Fisheries Oceanography, 10*(1), 110-131. doi:https://doi.org/10.1046/j.1054-6006.2001.00042.x

Williams, G. D., and Thom, R. M. (2001). *Marine and estuarine shoreline modification issues* (00-01215-009). Retrieved from

http://chapter.ser.org/northwest/files/2012/08/WDFW_marine_shoreline_white_paper.pdf
Winder, M., and Schindler, D. E. (2004). Climate change uncouples trophic interactions in an aquatic ecosystem. *Ecology, 85*, 2100–2106. doi:https://doi.org/10.1890/04-0151
Xie, Y., Michielsens, C. G. J., Gray, A. P., Martens, F. J., and Boffey, J. L. (2008). Observations of avoidance reactions of migrating salmon to a mobile survey vessel in a riverine environment. *Canadian Journal of Fisheries and Aquatic Sciences, 65*(10), 2178-2190. doi:10.1139/f08-128
Zabel, R. W., Scheuerell, M. D., McClure, M. M., and Williams, J. G. (2006). The Interplay between Climate Variability and Density Dependence in the Population Viability of Chinook Salmon. *Conservation Biology, 20*(1), 190-200. doi:http://dx.doi.org/10.1111/j.1523-1739.2005.00300.x

6. APPENDIX A

Lummi Island Ferry Breakwater Replacement Project

Marine Mammal Monitoring Plan

December 2, 2019

Dates

Due to NMFS and the U.S. Fish and Wildlife Service (USFWS) in-water work timing restrictions to protect ESA-listed salmonids, planned Whatcom County Public Works (WCPW) in-water construction is limited to August 1 through February 15. For this project, in-water construction is planned to take place between August 1 and October 15, 2020.

Work Description

- Vibratory removal of 140 12-inch diameter timber piles.
- Vibratory driving of 6 -24-inch steel piles with no proofing.
- Vibratory driving of 18 - 24-inch steel piles combined with under-reaming rock socketing.
- Four 12 inch diameter timber fender piles will be installed with a vibratory hammer at the waterward end of the breakwater.
- Nineteen temporary piles may also be installed if needed. Three of these piles will be 24- inch diameter steel to secure the work barge, and four 12" dia. steel or H-pile will be used to secure the breakwater pile template. Four template placements may be needed to complete the breakwater structure for a total of 16 temporary pile placements.

Duration Totals

- Vibratory and vibratory/drill pile driving on steel and timber piles shall not exceed 98 total HOURS.
- Vibratory and vibratory/drill pile driving on steel and timber piles shall not exceed 39 Total DAYS.
- Vibratory and vibratory/drill pile driving on steel and timber piles shall not exceed 6 HRS PER DAY.

Species Presence

Hale passage is rarely visited by Orcas, or by humpback whales. In the last nine years, only two sightings of transient Orcas have been documented near, but not in, the action area, and no sightings of humpback whales have been documented in or near the action area (Orca Network, 2018). Therefore, these species are unlikely to be exposed to elevated underwater noise associated with pile removal or installation.

Unique sighting days in Hale Passage from 2009 to 2018 (Orca Network, 2018).

Month	Number of Days Sighted
January	0
February	0
March	0
April	0
May	0
June	0
July	1 (Transient Orca pod south of action area)
August	0
September	1 (Transient Orca pod west of action area by Sandy Point)
October	0
November	0
December	0

Safety Zone/Zone of Exclusion

Dual criteria are used to assess marine mammal auditory injury (Level A harassment) as a result of underwater noise exposure (NMFS 2018). The dual criteria under the guidance provide onset thresholds in instantaneous peak SPLs as well as 24-hr cumulative sound exposure levels (SEL_{cum}) that could cause injury to marine mammals of different hearing groups. Table 2 summarizes the current NMFS marine mammal take criteria. Killer whales are considered mid-frequency cetaceans, and humpback whales are considered low frequency cetaceans.

The cumulative SEL is the sum-total sound exposure over a 24-hr period. Onset of injury (Level A harassment) from non- impulsive vibratory pile driving/ removal, and rock drilling noise for low and mid-frequency cetaceans begins at SEL_{cum} noise levels of 199 dB, and 198 dB respectively (Table 2). For installation of 24 inch steel piles, these isopleths are reached at 26.3 meters and 6.3 meters for low and mid-frequency cetaceans respectively (Table 2). For extraction of 12 inch timber piles, these isopleths are reached at 6.7 meters and 0.6 meters for low and mid-frequency cetaceans respectively.

NMFS guidance for Level B harassment is 120 dB_{rms} for non-impulsive vibratory pile driving/removal and rock drilling noise. For both installation of 24 inch steel piles and extraction of 12 inch timber piles, the level B harassment isopleth is reached at 6.3 km (3.8 miles) for all marine mammals (Table 2).

Table 2. NMFS Marine Mammal Take Criteria

Installation Method	Pile Size (inches)	Level A Injury					Level B Harassment
		LF Cetacean (199 SELcum)	MF Cetacean 198 SELcum	HF Cetacean 173 SELcum	Phocid 201 SELcum	Otariid 219 SELcum	120 dBrms
Vibratory install/ Removal	12 Timber	6.7 m	0.6 m	9.9 m	4.1 m	0.3 m	6.3 km
Vibratory Install/ rock socket	24 Steel	26.3 m	2.3 m	38.9 m	16 m	1.1	6.3 km
Vibratory Install	24 Steel	20.1 m	1.8 m	29.7 m	12.2 m	0.9 m	6.3 km
Vibratory install	12 H-Pile	1.3 m	0.1 m	1.9 m	0.8 m	0.1 m	6.3 Km
Vibratory install	12 Steel	2.7 m	0.2 m	4.0 m	1.7 m	0.1 m	6.3 km

Hearing Frequency Groups:
Low-frequency Cetaceans = baleen whales (humpback ,Northern minke, Sei, gray, blue)
Mid-frequency Cetaceans = dolphins, toothed whales, beaked whales, bottle nose whales (sperm whale, killer whale, bottlenose dolphin, Pacific White-sided dolphin)
High-frequency Cetaceans = true porpoises, river dolphins, cephalorhynchid. (Dall's Porpoise)
Phocid Pinnipeds – true seals (harbor seal, Northern Elephant seal, ribbon seal).
Otariid Pinnipeds – sea lions, fur seals (California and Stellar's sea lion, northern fur seal)

Safety zones [Zone of Exclusion (ZOE) and Zone of Influence (ZOI)] will be established and Protected species Observers (PSO) positioned before pile driving commences. The purpose of the Zone of Exclusion (ZOE) is to ensure that noise-generating activities are shut down before Level A (injury) take occurs. The purpose of the Zone of Influence (ZOI) is to ensure that noise-generating activities are shut down before Level B (harassment) take occurs.

In accordance with NMFS guidance, qualified Protected Species Observers (PSOs) will be present on site at all times during pile removal and driving to monitor for marine mammal presence. Data to be collected includes marine mammal behavior, overall numbers of individuals observed, frequency of observation, and the time corresponding to the daily tidal cycle.

Before the commencement of in-water construction activities, which include vibratory pile driving, under-ream drilling, and vibratory pile removal, WCPW will establish Level A harassment zones of exclusion (ZOE) where received underwater SPLs or SEL_{cum} could cause PTS (Table 2).

WCPW shall also establish Level B harassment zones of Influence (ZOI) where received underwater SPLs are higher than 120 dB_{rms} re 1 µPa for vibratory pile driving and pile removal (Table 2).

NMFS-approved protected species observers (PSO) shall conduct an initial survey of both ZOE and ZOI safety zones to ensure that no marine mammals are seen within the ZOE, and that no orcas or humpback whales are seen within the ZOI before pile driving or removal of a pile segment begins. If target marine mammals are found within or closely approaching the safety zones, pile driving of the segment would be delayed until target species move out of the safety zone.

We anticipate that, with spotting scopes / binoculars, PSOs will be able to see across Hale Passage to the opposite shore (1,500 m) from land based PSO stations (Figure 2). If pile driving of a segment ceases for 30 minutes or more and a target marine mammal is sighted within the designated safety zone prior to commencement of pile driving, the observer(s) must notify the pile driving operator (or other authorized individual) immediately and continue to monitor the safety zone. Operations may not resume until the target marine mammal has exited the safety zone or 30 minutes have elapsed since the last sighting in the ZOI, or 5 minutes have elapsed since the last sighting in the ZOE.

Monitoring for Level A and Level B Take

WCPW proposes the following in order to prevent Level A take in the ZOE, or Level B take in the ZOI:

- During all pile driving and removal, work will shut down if marine mammal approaches the ZOEs detailed in Table 2. Work will not resume until the marine mammal has been observed leaving the applicable ZOE, or if the animal has not been observed for at least 5 minutes.
- During vibratory driving, vibratory extraction, and drilling, three land-based PSOs will monitor the ZOI and ZOE detailed in Table 2, and collect data on marine mammal behavior, overall numbers of individuals observed, frequency of observation, and the time corresponding to the daily tidal cycle.
- The PSOs shall have spotting scopes available to supplement eye and binocular monitoring. The scope shall have minimum zoom lens of 20-60 x 80mm and will be of comparable quality to Nikon or Vortex brands. A sturdy tripod to support the scope shall be used.
- To verify the required monitoring distance, the ZOE and ZOI will be determined by using a range finder and/ or global positioning system device.
- The ZOE and ZOI will be monitored for the presence of target marine mammals 30 minutes before, during, and 30 minutes after any pile removal/installation activity.
- Monitoring will be continuous unless the contractor takes a significant break, in which case, monitoring will be required 30 minutes prior to restarting pile removal.
- If target marine mammals are observed within the ZOIs, the PSO will immediately notify the pile driving operator (or other authorized individual) and continue to monitor the ZOI. Operations may not resume until the marine mammal has exited the ZOI, or 30 minutes have elapsed since the last sighting.

Minimum Qualifications for Protected Species Observers (Marine Mammal)

Qualifications for PSOs include:

- Visual acuity in both eyes (correction is permissible) sufficient for discernment of moving targets at the water's surface with ability to estimate target size and distance. Use of binoculars may be necessary to correctly identify the target.
- Experience or training in the field identification of marine mammals (cetaceans and pinnipeds).
- Sufficient training, orientation or experience with the construction operation to provide for personal safety during observations.
- Ability to communicate orally, by radio or in person, with project personnel to provide real time information on marine mammals observed in the area as necessary.
- Experience and ability to conduct field observations and collect data according to assigned protocols (this may include academic experience).
- Possess a smartphone or tablet capable of supporting ArcGIS Survey123 for marine mammal data collection (the survey forms will be provided by WCPW).

Figure 1 – Marine Mammal Monitoring Zone of Exclusion (ZOE)

Marine Mammal ZOE Monitoring Area Map

Figure 2. Marine Mammal Monitoring Zone of Influence (ZOI)