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

Refer to NMFS No:
WCR-2017-6210

August 1, 2017

Daniel Drais
Environmental Protection Specialist
Federal Transit Administration
Federal Building, Suite 3142
Seattle, Washington 98174-1002

Re: Reinitiation of Endangered Species Act Section 7(a)(2) Biological Opinion, Letter of Concurrence, and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response for the Mukilteo Multimodal Project, Snohomish County, Washington. 171100190202 (Powder Mill Gulch-Frontal Possession Sound)

Dear Mr. Drais:

Thank you for your letter of January 12, 2017, requesting reinitiation of consultation with NOAA's National Marine Fisheries Service (NMFS) pursuant to section 7 of the Endangered Species Act of 1973 (ESA) (16 USC 1531 et seq.) for the Mukilteo Multimodal Project. Thank you, also, for your request for consultation pursuant to the essential fish habitat (EFH) provisions in Section 305(b) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA) (16 USC 1855(b)) for this action. In the enclosed opinion, NMFS concludes that the proposed actions are not likely to jeopardize the continued existence of Puget Sound Chinook salmon, Puget Sound steelhead, southern resident killer whales (SRKW), humpback whales, yelloweye rockfish, and bocaccio, and is not likely to destroy or adversely modify Puget Sound Chinook salmon, Puget Sound steelhead, SRKW, yelloweye rockfish, and bocaccio critical habitat.

NMFS is not including an incidental take authorization for marine mammals at this time because incidental take of marine mammals has not been authorized under section 101(a)(5) of the Marine Mammal Protection Act (MMPA) and/or its 1994 Amendments. Following the issuance of such regulations or authorizations of marine mammals, NMFS may amend this document to include an incidental take statement for marine mammals.

The document also contains the results of the MSA Essential Fish Habitat (EFH) consultation. The Federal Transit Administration (FTA) determined that the project will adversely affect EFH. NMFS concurs with this determination and is, therefore, providing conservation recommendations pursuant to the MSA (section 305(b)(4)(A)). The FTA must respond to these recommendations within 30 days (MSA section 305(b)(4)(B)).

Please contact Jennifer Quan at (360) 753-6054 or by email at Jennifer.Quan@noaa.gov if you have any questions concerning this consultation, or if you require additional information.

Sincerely,

for Barry A. Thom
Regional Administrator

cc: Leslie Durham, USFWS
Rick Huey, WSF
Kevin Bartoy, WSF
Michelle Meade, WSDOT

Reinitiation of Endangered Species Act (ESA) Section 7(a)(2) Biological Opinion and Letter of Concurrence, and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Consultation

for the

Mukilteo Multimodal Project
Snohomish County, Washington

NMFS Consultation Number: WCR-2017-6210

Action Agency: Federal Transit Administration

Affected Species and NMFS' Determinations:

ESA-Listed Species	Status	Is Action Likely to Adversely Affect Species or Critical Habitat?	Is Action Likely To Jeopardize the Species?	Is Action Likely To Destroy or Adversely Modify Critical Habitat?
Puget Sound ESU Chinook salmon (*Oncorhynchus tshawytscha*)	Threatened	Yes	No	No
Puget Sound DPS steelhead (*O. mykiss*)	Threatened	Yes	No	No
Yelloweye rockfish (*Sebastes ruberrimus*)	Threatened	Yes	No	No
Bocaccio (*S. paucispinis*)	Endangered	Yes	No	No
Southern resident killer whale DPS (*Orcinus orca*)	Endangered	Yes	No	No
Humpback whale (*Megaptera novaeangliae*)	Endangered	Yes	No	N/A
Southern DPS North American Green sturgeon (*Acipenser medirostris*)	Threatened	No	No	No
Southern DPS Pacific eulachon (*Thaleichthys pacificus*)	Threatened	No	No	No

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

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

Issued By:

Barry A. Thom
Regional Administrator

Date: August 1, 2017

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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. 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 USC 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). A complete record of this consultation is on file at the Oregon and Washington Coastal Office.

The Washington State Ferries (WSF) Division of the Washington State Department of Transportation (WSDOT) will carry out the project. The U.S. Federal Transit Administration (FTA) is the lead Federal agency and will fund the project, in part. The U.S. Army Corps of Engineers (USACE) will issue a permit under Section 404 of the Clean Water Act (CWA), and NMFS may issue a letter of authorization under the Marine Mammal Protection Act (MMPA).

1.2 Consultation History

On November 2, 2012, the FTA submitted a biological assessment (BA) to NMFS for the Mukilteo Multimodal Project and requested consultations under both ESA and MSA. NMFS received additional project information during meetings and via email exchanges between November 2, 2012, and April 23, 2013. Upon receiving additional information, NMFS initiated consultation on April 23, 2013. NMFS issued an opinion for the project on July 31, 2013 (NMFS Tracking No. WCR-2012-9334).

Since the opinion was issued, several changes have been made to the project that have the potential to affect listed species. In particular, the number and type of piles has changed and the overall duration of pile driving has increased beyond what was considered in the original opinion. Also, three species of rockfish have been listed under the ESA since 2012; however, as of March 31, 2017, canary rockfish (*Sebastes pinniger*) were since delisted and, therefore, will not be addressed further in this opinion.

FTA requested reinitiation of the consultation on January 12, 2017. NMFS submitted a request for additional information March 24, 2017, and received a response on April 4, 2017. Upon receiving the additional information, NMFS initiated consultation on April 13, 2017. The basis

for NMFS's concurrence with "not likely" determinations are presented in Section 2.12 of this document.

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). "Interrelated actions" are those that are part of a larger action and depend on the larger action for their justification. "Interdependent actions" are those that have no independent utility apart from the action under consideration (50 CFR 402.02). The Proposed Action sections of the original opinion are incorporated by reference here, except to the extent that they are inconsistent with the changes described blow, in which case the description of the changes prevail.

WSF proposes to relocate the existing Mukilteo Ferry Terminal approximately 1/3 of a mile east of the existing location in downtown Mukilteo. The proposed relocation is to the former U.S. Department of Defense Fuel Supply Point facility (the Tank Farm property) that had a large pier that extended into Possession Sound (the Tank Farm pier). A new roadway will connect State Route (SR) 525 east to the Mukilteo Commuter Rail station and continue to the ferry terminal.

The project was separated into two phases: Phase I included the demolition of the Tank Farm pier and dredging that was needed for the new navigation channel; Phase II included constructing the new ferry terminal, removing the existing terminal, relocating the fishing pier, and conducting subsurface sampling. While construction of Phase I was underway, WSF continued to design Phase II. During the design process, WSF found it necessary to change some of the structural materials, construction techniques, and sequencing of work, thus requiring reinitiation of ESA consultation.

Project elements that are included in Phase II and addressed in this reinitiation are described in the following sections.

1.3.1 Marine Components

Project construction will begin in 2017. WSF will conduct all in-water work between August 1, 2017 and February 15, 2018. WSF will conduct the following activities in marine waters:

- install the new terminal and trestle;
- place riprap to stabilize the in-water slope;
- construct a transfer span and a pedestrian overhead loading structure;
- construct wingwalls on either side of the trestle;
- relocate the floating dolphin from the old terminal to the new terminal;
- remove the existing terminal;
- remove the inner dolphin;
- install promenade retaining walls and stabilize the upland slope
- construct a new fishing pier and day moorage just east of the new terminal;
- remove the existing fishing pier; and
- install a new stormwater outfall.

Table 1 summarizes new project elements or structures that will be removed from below mean higher high water (MHHW).

Table 1. Summary of new and removed overwater and in-water project elements.

Element	New Overwater Structure	Removed Overwater Structure	New piles (number, type, diameter)*	Removed piles (number, type, diameter)
Terminal and Trestle	2,464 sf	8,120 sf	135, steel, H-piles	248, creosote, various
			25, steel, 30-inch	
			1, steel, 24-inch (temporary)	
Transfer Span and Overhead Loading Structure	1,600 sf		2, drill shaft, 78-inch	
			3, steel, 30-inch (temporary)	
	2,600 sf		1, drill shaft, 120-inch	
			68, steel, 24-inch (temporary)	
Wingwalls and Dolphins			20, steel, 24-inch	
			10, steel, 30-inch	
			12, steel, 36-inch	
Floating Dolphin Anchor System			4, steel, H-pile	
Inner Dolphin Pile				7, steel, 30-inch
Fishing Pier	3,455 sf	2,000 sf	28, steel, 24-inch	42, creosote, various
Tank Farm Pier		138,085 sf (completed)		3,900, creosote, various (completed)
Total	**10,119 sf**	**148,205 sf**	**117, steel, 24-inch (69 temporary)**	**4,190, creosote, various**
			38, steel, 30-inch	
			12, steel, 36-inch	
			2, drill shaft, 78-inch	
			1, drill shaft, 120-inch	**7, steel, 30-inch**
			139, steel, H-pile	

*Piles located below mean higher high water
sf =square feet

New Terminal and Trestle

To stabilize the underwater slope and improve the site soils below the new terminal, WSF will install 135 steel H-piles in a grid pattern over a 4,500-square-foot area. Installation of the steel H-piles will create a benthic disturbance of approximately 100 square feet per pile. The steel H-piles will be installed with a vibratory hammer fixed with a leader from a barge-mounted derrick. Each H-pile will take approximately 30 minutes to install. Ten piles will be installed per day, with 135 piles installed over 14 days.

WSF will construct the new terminal building along the shoreline west of the trestle. The building will extend slightly over the water, creating 2,464 square feet of overwater cover. WSF

will install 25 steel piles (30-inch-diameter) below MHHW to support the overwater portion of the terminal and the trestle. Piles will be vibrated into the substrate to the extent possible, then proofed with an impact hammer to the appropriate load-bearing depth. Only one vibratory or impact hammer will be in operation at a time. Durations for pile driving and removal are conservative, and the actual amount of time to install and remove piles will likely be less. Vibratory driving of each 30-inch-diameter steel pile will take approximately 60 minutes, three piles per day (240 minutes, or 4 hours, per day). Impact driving (3,000 strikes per pile) of 30-inch-diameter steel piles will take approximately 105 minutes per pile, three piles per day (315 minutes, or 5.25 hours, per day). The 25 piles associated with the terminal and trestle section will be installed over 9 days.

In-Water Slope Protection

The existing riprap slope protection extends only partway down the existing slope at the new terminal site. To prevent scour due to high throttle action by the ferries during low water or high flow events, approximately 375 cubic yards of riprap will be placed over an area of approximately 1,700 square feet between elevations of -24 feet to -35 feet mean lower low water (MLLW). The thickness of the riprap layer will be 6 feet or less and will include a 1.5-foot-thick bedding layer. At the base of the existing riprap, 540 cubic yards of existing riprap from a 3,600-square-foot area will be removed and replaced with 540 cubic yards of heavy, engineered riprap in the same area to prevent the potential destabilization of the revetment due to vessel propeller wash.

Transfer Span and Overhead Loading Structure

WSF will construct an overhead loading structure measuring 1,600 square feet on the west side of the trestle and a new transfer span measuring approximately 2,600 square feet. Two 78-inch-diameter drilled shafts will support the transfer span. Three steel piles (30-inch-diameter) and one drilled shaft (120-inch-diameter) will support the overhead loading structure. Construction for all three shafts at the vehicle transfer span and overhead loading structures will require temporary overwater platforms or a temporary construction access pier. Up to 68 temporary steel piles (24-inch-diameter) may be required to support the platforms or pier. Installation will be accomplished with a vibratory hammer to the extent possible. If necessary, an impact hammer will be used to drive the piles to the required depth. It is likely that at least some of the temporary piles will require 2 to 5 feet of proofing to support construction equipment. Impact driving (300 strikes per pile) of temporary, 24-inch-diameter steel piles will take approximately 15 minutes per pile.

WSF will install drilled shafts by first vibrating the steel casings into the soil. After the casing is installed, the WSF will excavate the interior of the casing and pour in concrete. Each casing will take approximately 60 minutes to vibrate into place, and the three casings will be installed in 3 days.

Wingwalls

WSF will construct two wingwalls, each measuring 900 square feet, on either side of the waterward end of the transfer span. Twenty steel piles (24-inch-diameter) and 6 steel piles (36-inch-diameter) will support each of the two wingwalls, for a total of 26 steel piles. WSF will also construct fixed dolphins just beyond the wingwalls using 10 steel piles (30-inch-diameter) and 6 steel piles (36-inch-diameter). WSF will use a vibratory hammer to install all 42 steel piles. Because the wingwalls and dolphins are not load-bearing structures, they will not need to be proofed with an impact hammer. Vibratory installation of each 24-inch-, 30-inch-, and 36-inch-diameter steel pile will take approximately 60 minutes. Three piles will be installed per day, with 42 piles installed over 14 days.

Floating Dolphin Anchor System

WSF will tow a floating dolphin measuring 4,600 square feet from the existing terminal and will use six new anchors (four steel H-pile anchors and two stockless anchors) and chains to anchor it at the new ferry terminal site. The four steel H-pile anchors will be installed using a vibratory hammer and will be either flush with or below the mudline. The installation of each steel H-pile will take approximately 30 minutes per pile; all 4 piles will be installed in 1 day. The stockless anchors will consist of either one anchor, or two to three anchors in a series. Anchor chains will be secured to the anchors and again to the floating dolphin. All anchors and chains will be proof-tested prior to attaching to the floating dolphin. Most of the anchor chain will lie in the mud during non-operational periods (when the vessels are not in contact with the structure).

Existing Terminal Removal

WSF will remove the existing terminal after completing the new terminal. The existing terminal covers 8,120 square feet of aquatic habitat and contains 248 creosote piles. Demolition of the terminal will remove approximately 406 tons of creosote-treated timber from the aquatic environment. Demolition will take approximately 2 weeks between July 15 and October 15, and will occur from land and from a barge containing the necessary removal and containment equipment. To provide additional support for the moored barge, one temporary steel pile (24-inch-diameter) will be installed with a vibratory hammer as a breasting pile west of the removed fishing pier. Vibratory driving of the 24inch-diameter steel pile will take approximately 60 minutes.

Inner Dolphin Pile Removal

The right inner dolphin pile at the existing facility is composed of seven steel piles (30-inch-diameter). Vibratory removal of these piles will take approximately 30 minutes per pile; all seven piles will be removed in 1 day.

Promenade Retaining Walls and Stabilize Upland Slope

WSF will install a promenade, which requires several upland retaining walls. The bases of two of the walls will be approximately 5 feet above MHHW. The walls will be made of mechanically

stabilized earth (MSE) atop a reinforced slope. The promenade slope reinforcement H-piles will be installed first from the land side of the proposed promenade wall alignment. Following installation of the H-piles, the MSE portion of the proposed walls will be constructed using bottom-up construction from the original grade to establish the final grade of the promenade. The upland MSE/H-pile walls will be installed using an impact hammer; installation will take approximately 20 minutes per pile; 10 piles will be installed per day; 112 piles will be installed over 12 days. Of the 112 H-piles, 26 will be located approximately 2 to 3 feet above MHHW. The remaining 86 piles will be approximately 12 to 13 feet above MHHW. No in-water work will occur during installation of piles for the promenade.

New Fishing Pier

The new fishing pier will be located just east of the new terminal and will cover 3,455 square feet. The public fishing pier will be supported by up to 28 steel piles (24-inch-diameter), 23 of which will be below MHHW. The pier gangway will be approximately 80 feet by 5 feet and will have a float approximately 8 feet by 15 feet. The steel piles (24-inch-diameter) will be installed using a vibratory driver; each will take approximately 60 minutes to install. Three piles will be installed per day; the 28 piles will be installed over 10 days.

Existing Fishing Pier Removal

The existing fishing pier covers 2,000 square feet of marine water and contains 42 creosote piles.WSF will remove the existing fishing pier after the new fishing pier is in place.

New Stormwater Outfall

WSF will install a new stormwater outfall just east of the new ferry terminal location. The outfall will likely require vibratory installation of a sheet pile cofferdam to isolate the work area while the outfall is installed. However, directional drilling may be used to install the outfall, which would eliminate the need for a cofferdam and trenching.

If a cofferdam is required, construction of the stormwater outfall would include work on the beach between MHHW and -4-foot MLLW, and removal of some riprap along the shoreline to access the area. Approximately 135 sheet piles will be installed with a vibratory hammer around a 30-foot-wide by 40-foot-long area (90 feet below MHHW and 45 feet above MHHW). The vibratory driving of each steel sheet pile will take approximately 30 minutes per pile; three sheet piles will be installed per day, with 90 sheet piles installed below the MHHW over 30 days. The area behind the sheet piles will be dewatered and excavated (trenched). A 30-inch-diameter, concrete or polyvinyl chloride (PVC) outfall pipe will be set in the trench. Sediments will be backfilled around the excavated area and regraded, and approximately 160 cubic yards of engineered riprap will be placed at the mouth of the outfall. The sheet piles will then be removed.

1.3.2 Land Components

WSF will conduct the following activities on land:

- install an upland test pile to confirm load-bearing capacity;
- install quarry spall to protect upland slopes;
- realign and extend First Street from a new intersection with State Route 525 (SR 525) to the new ferry terminal and a new bus transit facility, and add sidewalks and bus lanes;
- construct a new public parking lot between the railroad and First Street;
- construct a new vehicle holding area and a toll building;
- remove the upland components of the existing ferry terminal;
- place 1 to 7 feet of fill (depending on the location) over the new terminal site to avoid contaminated soils and archaeological resources; and
- remove any contaminated soils encountered during construction and dispose of them at existing upland facilities.

To minimize contaminant release from upland areas, WSF will:

- Test soils in areas of excavation prior to ground-disturbing activities;
- Dispose of contaminated soils at permitted locations;
- Test groundwater in excavation and infiltration areas prior to the start of construction;
- Prevent stormwater from contacting contaminated soils or groundwater; and
- Dispose of contaminated groundwater at an offsite facility.

1.3.3 Stormwater Treatment

Existing impervious surface in the project area totals 41.26 acres, of which 8.1 acres are pollution-generating. The project will create an additional 0.8 acre (8.9 acres total), of pollution-generating impervious surface (PGIS), mostly by converting the impervious surface of the Tank Farm property to roadway and holding areas. Of the 8.9 acres, 1.1 acre will receive enhanced treatment prior to infiltration through the development of nine bioretention facilities and five modular wetland systems. The roof of the terminal building will not receive treatment because it is not considered PGIS. The remaining 7.8 acres will discharge stormwater to Possession Sound via two outfalls: an existing 24-inch-diameter storm drain outfall within Park Avenue, and a proposed 30-inch-diameter PVC or concrete outfall pipe located east of the terminal building. WSF will sweep the new terminal quarterly with a vacuum sweeper.

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

The ESA established 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. Section 7(b)(3) requires that, at the conclusion of consultation, NMFS provides 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.
NMFS determined the proposed action is not likely to adversely affect the southern Distinct Population Segment (DPS) North American green sturgeon (*Acipenser medirostris*) and the southern DPS Pacific eulachon (*Thaleichthys pacificus*) or their critical habitat. Our concurrence is documented in Section 2.12, “Not Likely to Adversely Affect” Determinations.

2.1 Analytical Approach

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

This biological opinion relies on the regulatory definition of “destruction or adverse modification,” which “means a direct or indirect alteration that appreciably diminishes the value of critical habitat for the conservation of a listed species. Such alterations may include, but are not limited to, those that alter the physical or biological features essential to the conservation of a species or that preclude or significantly delay development of such features” (81 FR 7214).

The designation(s) of critical habitat for species use(s) the term primary constituent element (PCE) or essential features. The new critical habitat regulations (81 FR 7414) replace 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.

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

- Identify the rangewide status of the species and critical habitat expected to be adversely affected by the proposed action.
- Describe the environmental baseline in the action area.
- Analyze the effects of the proposed action on both species and their habitat using an “exposure-response-risk” approach.
- Describe any cumulative effects in the action area.
- Integrate and synthesize the above factors by reviewing the status of the species and critical habitat; and adding the effects of the action, the environmental baseline, and cumulative effects to assess the risk that the proposed action poses to species and critical habitat.
- Reach a conclusion about whether species are jeopardized or critical habitat is adversely modified.

- 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' current "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 current function of the essential PBFs that help to form that conservation value.

2.2.1 Status of the Species

For Pacific salmon, steelhead, and other relevant species, NMFS commonly uses four parameters to assess the viability of the populations that, together, constitute the species: spatial structure, diversity, abundance, and productivity (McElhany et al. 2000). These "viable salmonid population" (VSP) criteria, therefore, encompass the species' "reproduction, numbers, or distribution" as described in 50 CFR 402.02. When all four parameters are at appropriate levels, they maintain a population's capacity to adapt to various environmental conditions and allow it to sustain itself in the natural environment. These attributes are influenced by survival, behavior, and experiences throughout a species' entire life cycle, and these characteristics, in turn, are influenced by habitat and other environmental conditions.

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

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

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

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

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

Puget Sound Chinook Salmon

The Puget Sound Chinook salmon evolutionarily significant unit (ESU) was listed as threatened on June 28, 2005 (70 FR 37160). We adopted the recovery plan for this ESU in January 2007. The recovery criteria include:

- Two to four Chinook salmon populations in each of the five biogeographical regions of the ESU need to achieve viability;
- At least one population from each major genetic and life history group historically present within each of the five biogeographical regions needs to be viable;
- Populations that do not meet the viability criteria for all VSP parameters need to be sustained to provide ecological functions and preserve options for ESU recovery.

Spatial Structure and Diversity. The Puget Sound Chinook salmon ESU includes all naturally spawning populations of Chinook salmon from rivers and streams flowing into Puget Sound, including the Strait of Juan de Fuca from the Elwha River eastward, including rivers and streams flowing into Hood Canal, South Sound, North Sound and the Strait of Georgia in Washington. The ESU also includes the progeny of numerous artificial propagation programs (NWFSC 2015). The Puget Sound Technical Recovery Team (TRT) identified 22 extant population, grouped into five major geographic regions based on consideration of historical distribution, geographic isolation, dispersal rates, genetic data, life history information, population dynamics, and environmental and ecological diversity.

Between 1990 and 2014, the proportion of natural-origin spawners has trended downward across the ESU, with the Whidbey Basin the only major population group (MPG) with consistently high fractions of natural-origin spawner abundance. All other MPGs have either variable or declining spawning populations with high proportions of hatchery-origin spawners (NWFSC 2015).Overall, the new information on abundance, productivity, spatial structure and diversity since the 2010 status review supports no change in the biological risk category (NWFSC 2015).

Abundance and Productivity. Available data on total abundance since 1980 indicate that, although abundance trends have fluctuated between positive and negative for individual populations, there are widespread negative trends in natural-origin Chinook salmon spawner abundance across the ESU (NWFSC 2015). Productivity remains low in most populations, and hatchery-origin spawners are present in high fractions in most populations outside of the Skagit watershed. Available data now shows that most populations have declined in abundance over the past 7 to 10 years. Further, escapement levels for all populations remain well below the Puget Sound TRT planning ranges for recovery, and most populations are consistently below the

spawner-recruit levels identified by the Puget Sound TRT as consistent with recovery (NWFSC 2015).

Juvenile Chinook salmon use the action area as they migrate out of their natal streams and rivers. In a study to determine salmonid presence and use of the Mukilteo Ferry terminal, WSDOT used visual surveys to determine habitat use (Southard et al., 2006). During the visual surveys, no salmon were observed beneath the ferry terminal, six schools of salmon were observed within 10 meters of the ferry terminal, and five additional schools were observed 10 to 50 meters from the ferry terminal (Southard et al., 2006).

Monthly sampling in Bellingham Bay indicate that wild juvenile Chinook salmon are most abundant along the shoreline between May and July, then decrease in August (Rice 2004). The Bellingham Bay researchers captured two juvenile Chinook salmon in 14 sets in September, and no juvenile Chinook salmon were captured between October and December. Similarly, tow-net sampling in deeper portions of the nearshore reveal a consistent downward trend in Chinook salmon abundance in Skagit Bay between June and October (Rice et al., 2001). Tow-net sampling in Bellingham Bay also documented a summer peak and few juvenile Chinook salmon captured in October (Beamer et al., 2003). No tow-net sampling was conducted in Bellingham Bay during September. In comparison to the beach seine results, juvenile Chinook salmon presence in the Skagit Bay tow-net samples persisted later in the year (Rice et al., 2001). Tow-net sampling by Rice et al. (2011) showed that juvenile Chinook salmon presence in deeper nearshore areas of the Whidbey Basin peaks from July to September and that most those fish are unmarked (and presumably wild).

Limiting Factors. Limiting factors identified for Chinook salmon in the nearshore area of Possession Sound include loss of estuarine and nearshore habitats, and impacts to intertidal areas (Haring 2002). Nearshore habitat has been significantly altered due to extensive armoring and alteration of the marine shoreline, dredging of the river mouth and nearshore habitats, and log raft storage (Haring 2002). Intertidal areas are impacted by dredging and the removal of large woody debris to enhance navigation, and by diking and filling of side channels (Haring 2002).

Puget Sound Steelhead

The Puget Sound Steelhead TRT produced viability criteria, including population viability analyses (PVAs), for 20 of 32 demographically independent populations (DIPs) and 3 MPGs in the DPS (Hard et al., 2015). It also completed a report identifying historical populations of the DPS (Myers et al., 2015). The DIPs are based on genetic, environmental, and life history characteristics. Populations display winter, summer, or summer/winter run timing (Myers et al. 2015). The Puget Sound Steelhead TRT concluded that the DPS is currently at “very low” viability, with most of the 32 DIPs and all 3 MPGs at “low” viability.

The designation of the DPS as “threatened” is based upon the extinction risk of the component populations. Hard et al. (2015), identify several criteria for the viability of the DPS, including that a minimum of 40 percent of summer-run and 40 percent of winter-run populations historically present within each of the MPGs must be considered viable using the VSP-based

criteria. For a DIP to be considered viable, it must have at least an 85 percent probability of meeting the viability criteria, as calculated by Hard et al. (2015).
We are developing a recovery plan for this species.

Spatial Structure and Diversity. The Puget Sound steelhead DPS is the anadromous form of *O. mykiss* that occur in rivers, below natural barriers to migration, in northwestern Washington State that drain to Puget Sound, Hood Canal, and the Strait of Juan de Fuca between the U.S./Canada border and the Elwha River, inclusive. The DPS also includes six hatchery stocks that are considered no more than moderately diverged from their associated natural-origin counterparts: Green River natural winter-run, Hamma Hamma winter-run, White River winter-run, Dewatto River winter-run, Duckabush River winter-run, and Elwha River native winter-run (USDC 2014). Non-anadromous, ''resident'' *O. mykiss* occur within the range of Puget Sound steelhead but are not part of the DPS due to marked differences in physical, physiological, ecological, and behavioral characteristics (Hard et al., 2007).

DIPs can include summer steelhead only, winter steelhead only, or a combination of summer and winter run timing (e.g., winter run, summer run or summer/winter run). Most DIPs have low viability criteria scores for diversity and spatial structure, largely because of extensive hatchery influence, low breeding population sizes, and freshwater habitat fragmentation or loss (Hard et al. 2007). In the Central and South Puget Sound and Hood Canal and Strait of Juan de Fuca MPGs, nearly all DIPs are not viable (Hard 2015). More information on Puget Sound steelhead spatial structure and diversity can be found in NMFS' technical report (Hard et al., 2015).

Abundance and Productivity. Abundance of adult steelhead returning to nearly all Puget Sound rivers has fallen substantially since estimates began for many populations in the late 1970s and early 1980s. Smoothed trends in abundance indicate modest increases since 2009 for 13 of the 22 DIPs. Between the two most recent 5-year periods (2005-2009 and 2010-2014), the geometric mean of estimated abundance increased by an average of 5.4 percent. For seven populations in the Northern Cascades MPG, the increase was 3 percent; for five populations in the Central and South Puget Sound MPG, the increase was 10 percent; and for six populations in the Hood Canal and Strait of Juan de Fuca MPG, the increase was 4.5 percent. However, several of these upward trends are not statistically different from neutral, and most populations remain small. Inspection of geometric means of total spawner abundance from 2010 to 2014 indicates that 9 of 20 populations evaluated had geometric mean abundances fewer than 250 adults and 12 of 20 had fewer than 500 adults. Between the two most recent 5-year periods (2005-2009 and 2010-2014), several populations showed increases in abundance of between 10 and 100 percent, but about half have remained in decline. Long-term (15-year) trends in natural spawners are predominantly negative (NWFSC 2015).

There are some signs of modest improvement in steelhead productivity since the 2011 review, at least for some populations, especially in the Hood Canal and Strait of Juan de Fuca MPG. However, these modest changes must be sustained for a longer period (at least two generations) to lend sufficient confidence to any conclusion that productivity is improving over larger scales across the DPS. Moreover, several populations are still showing dismal productivity, especially those in the Central and South Puget Sound MPG (NWFSC 2015).

Little or no data is available on summer-run populations to evaluate extinction risk or abundance trends. Because of their small population size and the complexity of monitoring fish in headwater holding areas, summer steelhead have not been broadly monitored.

The extensive propagation of the Chambers Creek winter steelhead and the Skamania Hatchery summer steelhead stocks have contributed to the observed decline in abundance of native Puget Sound steelhead populations (Hard et al., 2007). Approximately 95 percent of the hatchery production in the Puget Sound steelhead DPS originates from these two stocks. The Chambers Creek stock has undergone extensive breeding to provide an earlier and more uniform spawn timing, which has resulted in a large degree of reproductive divergence between hatchery and wild winter-run fish. The Skamania Hatchery stock is derived from summer steelhead in the Washougal and Klickitat rivers and is genetically distinct from the Puget Sound populations of steelhead. For these reasons, Hard et al. (2007) concluded that all hatchery summer- and winter-run steelhead populations in Puget Sound derived from Chambers Creek and Skamania Hatchery stocks should be excluded from the DPS. NMFS included two hatchery populations that were derived from native steelhead, the Green River winter-run and the Hamma Hamma winter-run, as part of the DPS (72 FR 26722).

There are no natal streams in the areas of the Mukilteo Ferry Terminal that support Puget Sound steelhead; however, major river systems that support winter and summer steelhead include the Snohomish River (approximately 7 shoreline miles north), Stillaguamish River (approximately 15 shoreline miles north), Skagit River (approximately 20 shoreline miles north), and the Duwamish/Green River (approximately 30 shoreline miles south). In addition, numerous small streams in the Sinclair/Dyes Inlets and southern Puget Sound rivers and streams support winter-run steelhead.

Tow-net sampling (deeper nearshore) and beach seine sampling (shallow nearshore) around Puget Sound have found few steelhead. In tow-net sampling in north and south Puget Sound, NMFS captured a total of 18 steelhead (Rice, unpublished data). Although the total sampling data was not available, the mean steelhead catch ranged from 0 to 0.2 per net in north Puget Sound and 0.1 to 0.8 per net in south Puget Sound (Rice, unpublished data).

Limiting Factors. Similar to the limiting factors identified for Chinook salmon, steelhead are limited by impacts to nearshore, estuarine, and intertidal habitats (Haring 2002). Historic dredging of river mouths and armoring of the marine and estuarine shorelines have greatly altered the nearshore habitat (Haring 2002). Intertidal areas are impacted by dredging and the removal of large woody debris to enhance navigation, and by diking and filling of side channels (Haring 2002).

Yelloweye Rockfish

Puget Sound/Georgia Basin yelloweye rockfish were listed as threatened under the ESA on April 28, 2010 (75 FR 22276). Yelloweye rockfish are iteroparous, viviparous (fertilize eggs internally), and are long-lived (over 118 years) (Leaman 1991). As adults, yelloweye rockfish generally inhabit deep waters with steep and complex bathymetry. Their diets are diverse and include many species of marine invertebrates and fish. Successful recruitment occurs only

sporadically and may be associated with broad-scale environmental conditions (Tolimieri and Levin 2005).

In Puget Sound, embryonic fish are released from female yelloweye rockfish in early spring to late summer (Washington et al., 1978), peaking in May and June. Larval rockfish presence in the water column has been documented throughout the major basins of Puget Sound, with the highest densities occurring between April and September (Greene and Godersky 2012). Larval rockfish are often observed under free-floating algae, seagrass, and detached kelp (Love et al., 2002), and may also occupy the full water column (Weis 2004). Pelagic larval duration (the amount of time spent adrift before setting to juvenile habitat) varies by species and environmental conditions (NMFS 2016a).

Juvenile yelloweye rockfish are not typically found in intertidal waters (Love et al., 1991; Studebaker et al., 2009). A few juveniles have been documented in shallow nearshore waters (Love et al., 2002; Palsson et al., 2009), but most settle in habitats along the shallow range of adult habitats in areas of complex bathymetry starting at an age of 3 to 6 months (Love et al., 2002). As they grow, juvenile rockfish gradually move to areas of high rugosity (roughness) and rocky habitat in deeper waters (Love et al., 1991; Love et al., 2002; Johnson et al., 2003). Juvenile yelloweye rockfish have been rarely documented in Puget Sound (Palsson et al., 2009). This may be due to a relative lack of studies in Puget Sound that assessed nearshore rockfish assemblages prior to the onset of fisheries removals of adult rockfish. Most small juvenile rockfish are difficult to identify at the species level (Love et al., 2002).

Spatial Structure and Diversity. Adult yelloweye rockfish remain near the bottom (to depths from approximately 90 to 1,394 feet) and have relatively small home ranges (Love et al., 2002). Prior to contemporary fishery removals, each of the major basins in the range of the DPS likely hosted populations of yelloweye rockfish, though their distribution was not uniform throughout the Puget Sound basins (Williams et al., 2010). It is likely that natural biogeographic limits to rockfish dispersal (as evidenced by a population of yelloweye rockfish in Hood Canal that is separate from the rest of the Puget Sound/Georgia Basin yelloweye rockfish population) and distribution make them particularly susceptible to localized depletion due to fishery harvest (NMFS 2016a).

Yelloweye rockfish spatial structure and connectivity has been reduced by the decline of fish within each basin. This reduction is likely most acute within the basins of Puget Sound proper. The severe decline of fish in these basins may eventually result in a contraction of the DPS' range (Drake et al., 2010). Although yelloweye rockfish are probably most abundant within the San Juan Basin, the likelihood of juvenile recruitment from this basin to the adjacent basins of Puget Sound proper is naturally low because of the generally retentive circulation patterns that occur within each of the major Puget Sound basins. Combined with limited adult movement, yelloweye rockfish DPS viability may be highly influenced by the localized loss of populations within the DPS, which decreases spatial structure and connectivity (NMFS 2016a).

Abundance and Productivity. Female yelloweye rockfish produce from 1 to 3 million larvae annually, depending on age and body size. There have not been historic or contemporary systematic surveys of rockfish populations in all Puget Sound basins (Drake et al., 2010).

Despite this limitation, there is clear evidence that the yelloweye rockfish abundance has declined dramatically (Drake et al., 2010). The total rockfish population in the Puget Sound region is estimated to have declined around 3 percent per year for the past several decades, which corresponds to an approximately 70 percent decline from 1965 to 2007 (Drake et al., 2010). Catches of yelloweye rockfish have declined as a proportion of the overall rockfish catch (Drake et al., 2010). These patterns are consistent with the results of a study that assessed historical trends in rockfish abundance based on local knowledge of resource users and scientists (Beaudreau and Levin 2014).

Yelloweye rockfish productivity is influenced by long generation times that reflect intrinsically low annual reproductive success. Natural mortality rates have been estimated from 2 to 4.6 percent (Wallace 2007). Productivity may also be impacted by Allee effects, which occur as adults are removed by fishing and the density and proximity of mature fish decreases, reducing the opportunity of finding mates (Hutchings and Reynolds 2004).

Limiting Factors. Puget Sound/Georgia Basin yelloweye rockfish are threatened by fisheries and incidental capture as bycatch in other fisheries, and by the increase in noise in the aquatic environment. The hearing sensitivities of Puget Sound/Georgia Basin yelloweye rockfish have not been studied; however, they produce low frequency sounds (lower than 900 Hertz [Hz]) (Sirovic and Demer 2009) and are believed to be low-frequency hearing generalists (Croll et al., 1999).

Bocaccio

NMFS listed the Puget Sound/Georgia Basin bocaccio as endangered under the ESA in April 2010 (75 FR 22276). The listing includes bocaccio throughout the Puget Sound, which encompasses all waters south of a line connecting Point Wilson on the Olympic Peninsula and Partridge on Whidbey Island; West Point on Whidbey Island, Deception Island, and Rosario Head on Fidalgo Island; and the southern end of Swinomish Channel between Fidalgo Island and McGlinn Island, and the Strait of Georgia, which encompasses the waters inland of Vancouver Island, the Gulf Islands, and the mainland coast of British Columbia.

Like yelloweye rockfish, bocaccio are iteroparous and long-lived, generally living to 50 years (Leaman 1991; Love et al., 2002). Although adult bocaccio also inhabit deep waters (90 to 1,394 feet) with complex benthic habitats, they have larger home ranges than yelloweye rockfish and spend time suspended in the water column (Love et al., 2002; Friedwald 2009). Female bocaccio produce 1 to 3 million eggs, are viviparous (fertilize eggs internally), and release larvae between January and April (Love et al., 2002). Parturition peaks for bocaccio in February (Greene and Godersky 2012).

Young-of-the-year bocaccio occur on shallow rocky reefs and nearshore areas (Love et al., 2002). Young bocaccio associate with macroalgae, especially kelps and sandy areas that support seagrasses. They form aggregations near the bottom in association with drift algae and throughout the water column in association with canopy-forming kelps (NMFS 2016a). Habitat formed by kelp provides structure for feeding, refuge from predators, and reduced currents that enable energy conservation for juvenile bocaccio.

Spatial Structure and Diversity. Bocaccio likely historically occupied each major basin of the Puget Sound/Georgia Basin, but not uniformly (Williams et al., 2010). Wide distribution enables each species to potentially exploit good habitat that may be naturally limited in portions of Puget Sound, and to protect them from potentially negative environmental fluctuations or conditions. Wide spatial distribution also provides a measure of protection from larger scale anthropogenic changes that damage habitat suitability, such as oil spills or hypoxia that can occur within one basin but not necessarily the other basins (NMFS 2016a). Exchange of water masses that influence larval transport and population connectivity between the basins of Puget Sound is naturally restricted by relatively shallow sills located at Deception Pass, Admiralty Inlet, the Tacoma Narrows, and in Hood Canal (Burns 1985). When localized depletion of rockfish occurs, it can reduce resiliency of the entire DPS (Hamilton 2008).

Bocaccio may have been historically limited in their spatial distribution. They were historically most abundant in the main basin and South Sound (Drake et al., 2010; Williams et al., 2010) with no known documented occurrences in the San Juan Basin until 2008 (Pacunski et al., 2013). Spatial structure and connectivity in the DPS likely comes from the propensity of some adults and pelagic juveniles to migrate long distances, which could re-establish aggregations of fish in formerly occupied habitat (Drake et al., 2010). The apparent reduction of populations of bocaccio in the main basin and South Sound represents a further reduction in the historically limited distribution of bocaccio, and adds significant risk to the viability of the DPS (NMFS 2016a).

Larval rockfish could occur within the project and action area, though they are readily dispersed by currents after they are born, making the concentration or probability of presence of larvae in any one location extremely small (NMFS 2003). According to Greene and Godersky (2012), pelagic larvae presence in Puget Sound is seasonal, with the highest densities occurring between April and September. The vicinity of the existing and proposed ferry terminal locations does not provide ideal habitat for adult rockfish, which prefer deeper waters with rocky substrate. Any rockfish in the vicinity of the existing and proposed ferry terminal locations are likely pelagic larvae or possibly juveniles.

Abundance and Productivity. As with yelloweye rockfish, there is no single, reliable historical or contemporary abundance estimate for the bocaccio DPS in the Puget Sound/Georgia Basin (Drake et al., 2010). The total rockfish population has declined about 3 percent per year for the past several decades, and catches of bocaccio have declined as a proportion of the overall rockfish catch (Drake et al., 2010). Bottom trawl and drop camera surveys did not detect bocaccio in Puget Sound proper (Williams et al., 2010). The lack of detected bocaccio from these sampling methods in Puget Sound is likely due to the following factors: 1) populations are depleted; 2) the general lack of rocky benthic areas in Puget Sound proper may lead to densities of bocaccio that are naturally less than the San Juan Basin; 3) the study design or effort may not have been sufficient to detect each species; and 4) bottom trawls do not effectively sample bocaccio habitats (i.e., high-relief rock). Though bocaccio were likely never a predominant component of the multi-species rockfish abundance within the Puget Sound/Georgia Basin, their present-day abundance is likely a fraction of their pre-contemporary fishery abundance (NMFS 2016a).

Bocaccio productivity is driven by high fecundity and episodic recruitment events that are largely correlated with environmental conditions (Tolimieri and Levin 2005). Natural annual mortality is approximately 8 percent (Palsson et al., 2009). Tolimieri and Levin (2005) found that the bocaccio population growth rate is around 1.01, indicating a very low intrinsic growth rate for this species. Demographically, this species demonstrates some of the highest recruitment variability among rockfish species, with many years of poor recruitment being the norm (Tolimieri and Levin 2005). Given their severely reduced abundance, Allee effects could be particularly acute for bocaccio, even considering the propensity of some individuals to move long distances and potentially find mates, though the extent of these effects is still unknown (NMFS 2016a).

Limiting Factors. Bocaccio are threatened by the effect of directed fisheries and incidental capture as bycatch in other fisheries, including salmon fisheries. They are also adversely affected by land use practices that have increased oxygen demands within their range, the loss of kelp habitat necessary for juvenile recruitment, and increased noise in the aquatic environment.

Southern Resident Killer Whales

NMFS listed the southern resident killer whale (SRKW) DPS as endangered under the ESA on November 18, 2005 (70 FR 69903) and designated them as depleted and strategic under the MMPA (68 FR 31980). NMFS issued the final recovery plan for the SRKW in January 2008 (NMFS 2008). This section summarizes status information from the recovery plan, the 5-year status review (NMFS 2011a), and other data.

The SRKW is a long-lived species, with a late onset of sexual maturity (NMFS 2008). Mothers and offspring maintain highly stable social bonds throughout their lives, which is the basis for the matrilineal social structure in the SRKW population (NMFS 2008). Groups of related matrilines form pods. Three pods—J, K, and L—make up the SRKW DPS. Vocal communication is advanced in SRKWs and is important to their social structure, navigation, and foraging (NMFS 2008). They consume a variety of fish and one species of squid, but salmon, particularly Chinook salmon, are their primary prey (Ford and Ellis 2006; Hanson et al., 2010).

Spatial Distribution and Diversity. The SRKW DPS is a single population that ranges as far south as central California and as far north as southeast Alaska. They spend considerable time in the Salish Sea, mostly around the San Juan Islands, from late spring to early autumn. Although the entire DPS can occur along central and southern Puget Sound at any time of the year, occurrence along the central and southern Puget Sound is more likely from late autumn to early spring.

The estimated effective size of the population (based on the number of breeding individuals under ideal genetic conditions) is very small, less than 30 whales or about one-third of the current population size (Ford et al., 2011). The small effective population size, the absence of gene flow from other populations, and documented breeding within pods may elevate the risks of inbreeding (Ford et al., 2011). In addition, the small effective population size may contribute to the lower growth rate of the SRKW population in contrast to the Northern Resident population (Ward et al., 2009; Ford et al., 2011).

Abundance and Productivity. As of January 2, 2017, the SRKW population comprises 78 individuals: J pod has 24 members; K pod has 19 members; and L pod has 35 members (Orca Network 2017). The historical abundance of SRKWs was between 140 and 400 whales (Olesiuk et al., 1990; Krahn et al., 2004). Between 1983 and 2010, population growth was variable, with an average annual population growth rate of 0.3 percent (The Center for Whale Research unpublished data).

One of the delisting criterion in the SRKW recovery plan is an average annual growth rate of 2.3 percent for 28 years (NMFS 2008). While this criterion has been met in recent years, the current small population size is not sufficient to achieve recovery (NMFS 2016b). Other factors limiting the growth rate of the population include the small number of breeding males, particularly in J and K pods, reduced fecundity, decreased sub-adult survivorship in L pod, and the total number of individuals in the population (NMFS 2008).
Southern resident killer whales are likely to be present within the action area in Possession Sound. The Whale Museum manages a long-term database of SRKW sightings and geospatial locations in inland marine waters of Washington. While these data are predominantly opportunistic sightings from a variety of sources (public reports, commercial whale watching, Soundwatch, Lime Kiln State Park land-based observations, and independent research reports), SRKWs are highly visible in inland waters and are widely followed by the interested public and research community. The dataset does not account for level of observation effort by season or location; however, it is the most comprehensive long-term dataset available to evaluate broad scale habitat use by SRKWs in inland waters. For these reasons, NMFS relies on the number of past sightings to assess the likelihood of SRKW presence in a project area and during work windows. A review of this dataset from the years 1990 to 2016 indicates that SRKWs have used the project vicinity during the months that in-water construction activities are proposed (Table 2).

Table 2. Total killer whale sightings per month in the project action area between 1990 and 2016. (Months corresponding to the in-water work window are highlighted in green.)

Month	Number of Sightings
August	17
September	5
October	21
November	28
December	22
January	18
February	13
March	16
April	17
May	21
June	5
July	1

Limiting Factors. Several factors may be limiting SRKW recovery, including the quantity and quality of prey, bioaccumulation of toxic chemicals, and disturbance from sound and vessels. Oil spills are also a risk factor. Multiple threats are likely acting in concert to impact SRKWs. Although it is not clear which threat or threats are most significant to the survival and recovery of the SRKW DPS, all of these threats are potential limiting factors in the population (NMFS 2008).

Humpback Whale

NMFS listed humpback whales as endangered under the Endangered Species Conservation Act (ESCA) in June 1970 (35 FR 18319). The ESA replaced the ESCA in 1973 and continued to list humpback whales as endangered. NMFS issued the final recovery plan for humpback whales in November 1991 (NMFS 1991). In 2016, NMFS revised the listing status to identify 14 distinct DPSs. Of those, four are endangered, one is threatened, and the remaining nine do not warrant listing (81 FR 62259). The four listed DPSs are Central America (endangered), Cape Verde Islands (endangered), Western North Pacific (endangered), Arabian Sea (endangered), and Mexico (threatened). Of these, Mexico and Central America occur off the coasts of Washington, Oregon, and California.

Spatial Structure and Diversity. In recent years, humpback whales have been sighted with increasing frequency within Puget Sound and the Salish Sea, primarily during the fall and spring; however, occurrence is relatively uncommon.

Abundance and Productivity. The multi-strata estimate for the Central America DPS is 411 (coefficient of variance = 0.30), which is lower than the Calambokidis et al. (2008) preliminary estimate of 500 and the estimate of 600 based on Barlow et al. (2011). The abundance estimate of the Central America DPS is 411 individuals, with an unknown population trend. The multi-strata estimate for the Mexico DPS is 3,264 (coefficient of variance = 0.06). This estimate is a significantly lower abundance estimate than the Calambokidis et al. (2008) estimate, and, with a coefficient of variation of 0.06, it is more reliable. The abundance estimate for the Mexico DPS is 3,264 individuals, and the population trend is unknown.

Limiting Factors. Factors that may be limiting humpback whale recovery include entanglement in fishing gear, collisions with ships, whale watch harassment, subsistence hunting, and anthropogenic sound (NMFS 1991). The number of entanglements off the coasts of California, Oregon, and Washington in 2015 was 54 confirmed humpback whales of 71 confirmed whale entanglements (NOAA Fisheries 2017).

2.2.2 Status of the Critical Habitat

This section examines the rangewide status of designated critical habitat for Puget Sound Chinook salmon, Puget Sound steelhead, SRKWs, yelloweye rockfish, and bocaccio. Critical habitat is not designated for humpback whale DPSs.

Puget Sound Chinook Salmon and Puget Sound Steelhead Critical Habitat

The critical habitat analysis is combined for Puget Sound Chinook salmon and Puget Sound steelhead because of the similarity of PBFs for each species, and the overlapping critical habitat areas.

NMFS designated critical habitat for the Puget Sound Chinook salmon ESU on September 2, 2005, and for the Puget Sound steelhead DPS on February 24, 2016. While the geographic extent of each ESU's and DPS's critical habitat is different, the PBFs are the same. Six PBFs were identified, but only PBF 4 (estuarine areas) and PBF 5 (nearshore marine areas) are applicable to the proposed project.

> PBF 4 **–** Estuarine areas free of obstruction and excessive predation with: 1) water quality, water quantity, and salinity conditions that support juvenile and adult physiological transitions between freshwater and salt water; 2) natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, and side channels; and 3) juvenile and adult foraging opportunities, including aquatic invertebrates and prey fish, supporting growth and maturation.
>
> PBF 5 **–** Nearshore marine areas free of obstruction and excessive predation with 1) water quality and quantity conditions and foraging opportunities, including aquatic invertebrates and fishes, supporting growth and maturation; and 2) natural cover including submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, and side channels.

As part of the process to designate critical habitat within the Puget Sound Chinook salmon ESU and Puget Sound steelhead DPS, NMFS assessed the conservation value of habitat within freshwater, estuarine and nearshore areas at the fifth field hydrologic unit code (HUC) scale. That scale corresponds generally to the watershed scale. The ratings were generally devised as "low," "medium," or "high" conservation value. To determine the conservation value of each watershed to ESU and DPS viability, the critical habitat analytical review team (CHART) evaluated the quantity and quality of habitat features (for example, spawning gravels, wood and water condition, side channels); the relationship of the area compared to other areas within the ESU; and the significance to the ESU of the population occupying that area. Thus, even a location that has poor quality of habitat could be ranked at high conservation value if that location was essential due to factors such as limited availability (e.g., one of a very few spawning areas), the unique contribution of the population it served (e.g., a population at the extreme end of geographic distribution), or other important role (e.g., obligate area for migration to upstream spawning areas).

Critical habitat throughout the Puget Sound basin has been degraded by numerous activities, including hydropower development, loss of mature riparian forests, increased sediment inputs, removal of large woody debris, intense urbanization, agriculture, alteration of floodplain and stream morphology, riparian vegetation disturbance, wetland draining and conversion, dredging, armoring of shorelines, marina and port development, road and railroad construction and maintenance, timber harvest, and mining. Changes in habitat quantity, availability, diversity,

stream flow, temperature, sediment load, and channel instability are common limiting factors of critical habitat.

Yelloweye Rockfish and Bocaccio Critical Habitat

The critical habitat analysis is combined for yelloweye rockfish and bocaccio because of the similarity of PBFs for each species, and the overlapping critical habitat areas. We did not describe PBFs of rockfish critical habitat but, rather, listed the PBFs that are essential to the conservation of adults and juveniles.

PBFs essential to the conservation of adult bocaccio and adult and juvenile yelloweye rockfish include benthic habitats or sites deeper than 98 feet that possess or are adjacent to areas of complex bathymetry consisting of rock and or highly rugose habitat. Several attributes of these sites determine the quality of the habitat including: 1) quantity, quality, and availability of prey species to support individual growth, survival, reproduction, and feeding opportunities; 2) water quality and sufficient levels of dissolved oxygen to support growth, survival, reproduction, and feeding opportunities; and 3) the type and amount of structure and rugosity that supports feeding opportunities and predator avoidance.

Physical and biological features essential to the conservation of juvenile bocaccio include juvenile settlement habitats located in the nearshore with substrates such as sand, rock, and/or cobble compositions that also support kelp. These are essential habitats for conservation because they contain features that promote forage opportunities, provide refuge from predators, and enable behavioral and physiological changes needed for juveniles to occupy deeper adult habitats. Several attributes of these sites determine the quality of the area; they include: 1) quantity, quality, and availability of prey species to support individual growth, survival, reproduction, and feeding opportunities; and 2) water quality and sufficient levels of dissolved oxygen to support growth, survival, reproduction, and feeding opportunities.
Although juvenile bocaccio are more commonly found associated with macroalgae, they are occasionally found along soft bottoms. There are eelgrass beds approximately 2,000 feet east of the proposed terminal location, and the dominant macroalgae species at the proposed location are sea lettuce, northern bladder chain, and kelp (DNR 2017).

The project will result in long-term beneficial effects to larval and juvenile rockfish through the reduction of overwater coverage, restoration of benthic habitat, and reduction of pollutants by removing creosote-treated treated piles.

Southern Resident Killer Whale

NMFS designated critical habitat for the SRKW DPS on November 29, 2006 (71 FR 69054). Critical habitat consists of three areas: the summer core area in Haro Strait and waters around the San Juan Islands, Puget Sound, and the Strait of Juan de Fuca. The following PBFs were identified as essential to their conservation: 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.

Water Quality. Water quality in Puget Sound is degraded (Puget Sound Partnership 2006, 2008). For example, toxic chemicals in Puget Sound persist and build up in marine organisms, including SRKWs and their prey, despite bans in the 1970s of some harmful substances and cleanup efforts. The primary concern for direct effects on whales from water quality is oil spills.

Prey Quantity, Quality, and Availability. Most wild salmon stocks throughout the Pacific Northwest are at fractions of their historical levels. Since 1994, NMFS has listed 28 ESUs and DPSs of salmon and steelhead in Washington, Oregon, Idaho, and California as threatened or endangered under the ESA. Overfishing, habitat loss, and hatchery practices are major causes of decline. Poor ocean conditions over the past two decades have also reduced wild populations. While wild salmon stocks have declined, hatchery production has been generally strong. Total Chinook salmon abundances increased significantly from the mid-1990s to the early 2000s, but have declined since the mid-2000s (PFMC and MEW 2008).

Contaminants and pollution also affect the quality of SRKW prey in Puget Sound. Contaminants enter marine waters and sediment from numerous sources, but they are typically concentrated near the shorelines in areas of high human population and industrialization. Once in the environment, these substances accumulate up the food change and reach high levels in long-lived apex predators like SRKWs. Juvenile Chinook salmon in Puget Sound may become burdened with pollutants because they tend to use nearshore habitats. Chinook salmon bio-accumulate increasing amounts of pollutants as they grow until they become prey size for SRKWs. In addition, vessels and sound may reduce the effective zone of echolocation and reduce availability of fish for SRKWs in their critical habitat (Holt 2008).

Passage. SRKWs are highly mobile and use a variety of areas for foraging and migration. Human activities can interfere with movements of the whales and impact their passage. Vessels and acoustic disturbance may present obstacles to whale passage, causing the whales to swim further and change direction more often. This increases energy expenditure and impacts foraging behavior (NMFS 2011b).

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 is defined as the geographical extent (in both aquatic and terrestrial environments) of the physical, chemical, and biological effects resulting from the proposed action, including direct and indirect effects, as well as effects of interrelated and interdependent activities. The action area for this project includes the construction footprint, areas where noise from pile driving will be above baseline levels (both in-air and in-water), and the extent of turbidity generated by in-water work.

The action area includes 42.7 square miles of Possession Sound, the aquatic area within the line of sight of the existing and new Mukilteo Ferry Terminal, framed by the extent of underwater noise from pile driving (Figure 1). Possession Sound is part of Puget Sound between Whidbey Island and the coastline of Snohomish County between the cities of Everett and Mukilteo.

Possession Sound connects the main Puget Sound basin to the south with Saratoga Passage and Port Susan to the north. The Snohomish River flows into Possession Sound at Port Gardner Bay.

All species listed in table of *Affected Species and NMFS' Determinations* on the cover page are reasonably certain to be within the action area during in-water work. The action area also contains critical habitat for Puget Sound Chinook salmon, Puget Sound steelhead, SRKWs, yelloweye rockfish, and bocaccio.

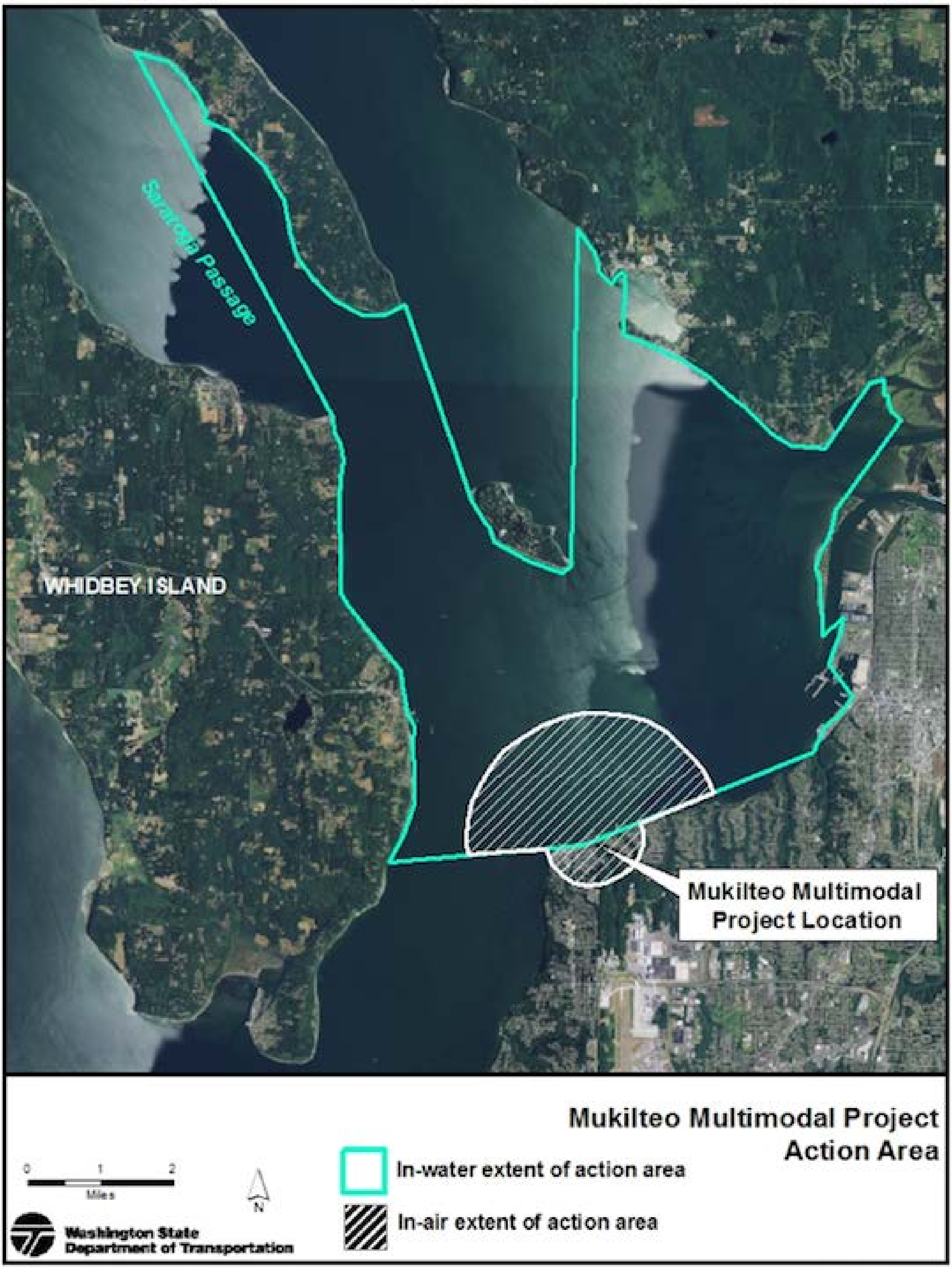

Figure 1. Mukilteo Ferry Terminal relocation action area.

2.4 Environmental Baseline

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 consultation, and the impact of state or private actions which are contemporaneous with the consultation in process (50 CFR 402.02).

Climate change affects listed marine mammals and listed fish species and their habitat throughout Washington. Several studies have revealed that climate change is affecting and will continue to affect salmonid habitat in nearly all tributaries throughout the state (Battin et al., 2007; ISAB 2007). While the intensity of effects will vary by region (ISAB 2007), climate change will generally alter aquatic habitat (water yield, peak flows, and stream temperature). As climate change alters the structure and distribution of rainfall, snowpack, and glaciers, these changes will alter riverine hydrographs. Climate and hydrology models project significant reductions in both total snow pack and low-elevation snow pack in the Pacific Northwest over the next 50 years (Mote and Salathé 2009). These changes will shrink the extent of the snowmelt-dominated habitat available to salmon. Such changes may restrict our ability to conserve diverse salmon life histories, especially spring-run Chinook salmon.

In Washington State, most models project warmer air temperatures, increases in winter precipitation, and decreases in summer precipitation. Average air temperatures in Washington State are likely to increase 0.1 to 0.6˚C per decade (Mote and Salathé 2009). Warmer air temperatures will lead to more precipitation falling as rain rather than snow. As the snow pack diminishes, seasonal hydrology will shift to more frequent and severe early large storms, changing stream flow timing and increasing peak river flows, which may limit salmon survival (Mantua et al., 2009). The largest driver of climate-induced decline in salmon populations in projected to be the impact of increased winter peak flows, which scour the streambed and destroy salmon eggs (Battin et al., 2007).

High water temperatures and lower spawning flows, together with increased magnitude of winter peak flows are all likely to increase salmon mortality. Higher ambient air temperatures will likely cause water temperatures to rise (ISAB 2007). Salmon and steelhead required cold water for spawning and incubation. As climate change progresses and stream temperatures warm, thermal refugia will be essential to persistence of many salmonid populations. Thermal refugia are important for providing salmon and steelhead with patches of suitable habitat while allowing them to undertake migrations through or to make foraging forays into areas with greater than optimal temperatures. To avoid waters above summer maximum temperatures, juvenile rearing may be increasingly found only in the confluence of colder tributaries or other areas of cold-water refugia (Mantua et al., 2009).

Climate change will make recovery targets for these salmon populations more difficult to achieve. Habitat action can address the adverse impacts of climate change on salmon. Examples include restoring connections to historical floodplains and freshwater and estuarine habitats to provide fish refugia and areas to store excess floodwaters, protecting and restoring riparian

vegetation to ameliorate stream temperature increases, and purchasing or applying easements to lands that provide important cold water or refuge habitat (Battin et al., 2007; ISAB 2007).

Climate change will also affect listed marine species. Effects from climate change in the marine environment include increased ocean temperature, increased stratification of the water column, and changes in intensity and timing of coastal upwelling. Direct studies on the effect of climate variability on rockfish are rare, but all the studies performed to date suggest that climate plays an extremely important role in population dynamics (Drake and Griffen 2010). Although the mechanism by which climate influences the population dynamics of rockfish remains unknown, several authors have reported negative correlations between the warm water conditions associated with El Niño and the population dynamics of rockfish (Moser et al., 2000). Field and Ralston (2005) reported that recruitment in all species of rockfish appeared to be correlated at large scales and hypothesized that such synchrony was the result of large-scale climatic phenomena. Tolimieri and Levin (2005) reported that bocaccio recruitment off California is correlated with specific sets of climate patterns. These phenomena are also believed to affect the population dynamics of Puget Sound/Georgia Basin yelloweye rockfish.

Effects of climate change will alter primary and secondary productivity, the structure of marine communities and, in turn, the growth, productivity, survival, and migrations of salmonids. A mismatch between earlier smolt migrations (due to earlier peak spring freshwater flows and decreased incubation period) and altered upwelling may reduce marine survival rates. Increased concentration of carbon dioxide reduces the availability of carbonate for shell-forming invertebrates, including some that are prey items for juvenile salmonids and rockfish species. In each of these cases, the specific effects on salmon and steelhead abundance, productivity, spatial distribution and diversity are poorly understood, but as a primary prey source for SRKWs, the effect on salmonids from climate change has potential to affect prey abundance as a PBF of SRKW critical habitat. Humpback whales primarily eat zooplankton and forage fish, but, to the degree that salmonids are prey of humpback whales, climate change is expected to negatively affect salmon as prey for humpbacks as well. Climate change could also indirectly affect humpback whales through trophic dynamics and available non-salmonid prey.

Possession Sound

Possession Sound is within the Whidbey Basin of Puget Sound. Human activities have degraded habitat in the basin through excessive sedimentation, failing septic systems, bulkheads, water quality degradation, and interruption of shoreline sediment sources and longshore transport processes. Approximately 22.5 percent of the Whidbey Basin shoreline is armored, particularly in the cities of Mukilteo and Everett and along the 3 miles of BNSF railroad between the two cities. The Whidbey Basin also has areas of low dissolved oxygen. Possession Sound is one of eight locations the Washington State Department of Ecology (Ecology) considers of highest concern for eutrophication. Human activities have degraded sediment quality. Nine percent of the Whidbey Basin marine area exceeds that state's sediment quality standards and the cleanup screening levels for one or more contaminants (Puget Sound Partnership 2008).
Possession Sound has significant vessel traffic. In addition to the multiple daily runs of WSF vessels, Possession Sound also has large vessels using the Port of Everett and the Naval Station Everett, commercial fishing boats, and numerous smaller recreational boats. Background noise

levels due to vessel traffic at the terminal exceed the 120 root-mean-square decibel level (dB_{RMS}) behavior disturbance threshold for marine mammals. Laughlin (2011) reported background noise levels at the Mukilteo Ferry Terminal within the functional hearing range for killer whales (122 dB_{RMS}) and for humpback whales (124 dB_{RMS}).

Existing Terminal

Substrates around the ferry terminal consist of coarse-grained sand, gravel, and cobble. The beach is gently sloped. The shoreline has little vegetation and steep retaining walls and riprap. WSF conducted an eelgrass survey in 2011 and found only one small eelgrass patch (less than 1 square foot) just east of the existing terminal. Possession Sound is classified as extraordinary for aquatic life use per WAC 173-201A-612. No parameters of concern have been identified in Ecology's 2008 303(d) list (EPA 2009).

The existing terminal covers 8,120 square feet of marine water and contains 248 creosote piles. The existing fishing pier covers 2,000 square feet of marine water and contains 42 creosote piles. The creosote piles degrade water quality in the action area by releasing polycyclic aromatic hydrocarbons (PAHs) into the marine environment. Water quality is a component of the SRKW critical habitat and Puget Sound Chinook salmon and Puget Sound steelhead (PBF 5) critical habitat. In addition to water quality effects, the pier is also a barrier to juvenile Chinook salmon migration, which further degrades PBF 5 of Puget Sound Chinook salmon and Puget Sound steelhead critical habitat.

Proposed Terminal Site

The proposed terminal site is on the Tank Farm property, which consists of approximately 20 acres of upland and 13 acres of adjacent offshore property. The upland portion of the property is 12 feet above mean sea level and is graded and flat. A protective riprap wall, approximately 10 feet high, separates the property from Possession Sound. Vegetation on the property is almost entirely non-native and consists of small trees, shrubs, and herbaceous plants, although there are some small native black cottonwoods (*Populus balsamifera* var. *trichocarpa*) and red alders (*Alnus rubra*).

The Tank Farm property is contaminated by past industrial uses, particularly when the site served as a fuel storage and loading facility. Testing in the 1970s and 1980s found petroleum hydrocarbons, volatile organic compounds, polychlorinated biphenyls (PCBs), and heavy metals in the soil, groundwater, surface, water, and sediments. The Air Force conducted a cleanup of the site in the 1990s and early 2000s. They installed a groundwater remediation treatment system of fuel product recovery, vapor extraction, and air sparge subsystems. This system operated on at least a portion of the site from 1997 until 2002, when performance monitoring of groundwater and surface water indicated that contaminants were at concentrations below the site-specific cleanup levels. In 2006, Ecology concluded that the monitoring was complete and, in 2008, removed the property from the Ecology Hazardous Sites List (NMFS 2013).

WSF discovered soil contamination on the site during archaeological investigations for the proposed action. WSF commissioned a study of soil and groundwater contamination on the Tank

Farm property in 2006. Investigations revealed elevated levels of petroleum hydrocarbons and benzene, toluene, ethylbenzene, and xylenes (NMFS 2013).

Aquatic substrates around the proposed terminal are primarily sand and silt. Riprap extends from the high intertidal area to approximately 20 feet waterward from the shore. Substrates underneath the removed Tank Farm pier location also contain large chunks of concrete that had fallen off the pier, as well as shell hash from shellfish that covered the pilings (NMFS 2013). WSF did not find any eelgrass during a 2011 survey of the footprint of the proposed terminal (NMFS 2013). The nearest eelgrass beds are on either side of the Mount Baker Terminal, more than 2,000 feet east of the proposed terminal location (NMFS 2013). The dominant macroalgae species at the proposed terminal location are sea lettuce, northern bladder chain, and kelp (NMFS 2013).

The beach is steeply sloped at the proposed terminal site, dropping to 30 feet below MLLW within 75 feet of the shoreline. The military dredged a berth for ships along the east side of the Tank Farm pier in the late 1940s, which created elevations east of the pier approximately 38 feet below MLLW. Water depth is shallower under the old Tank Farm pier location (14 feet below MLLW) due to a sediment mound. The mound may have been formed by sediments that drop out of seawater as wave energy was attenuated by the dense placement of pilings underneath the pier, it may have been created deliberately to provide support for the pier, or it may have resulted from placement of dredge material from the dredge channel (NMFS 2013).

Sediment sampling in 2003 along the Tank Farm property shoreline did not detect contaminants of concern above reporting limits or above Ecology Sediment Quality Standards; however, in 2009 composite tissue samples for mussels exceeded National Toxics Rule criteria for polychlorinated biphenyls and PAHs (Ecology 2010). Sediment sampling underneath and adjacent to the Tank Farm pier in March and April of 2012 revealed levels of contaminants above dimethyl methylphosphonate screening level criteria (NMFS 2013). Upper levels of sediment (from the surface to 8 feet deep) contained chlordane, an organochlorine pesticide. Lower levels of sediment (between 8 and 12 feet deep) contained PAHs. The sediment samples were from 3 to 5 feet from the creosote piles and did not capture the higher levels of PAHs that are likely to be in sediments immediately adjacent to the piles.

2.5 Effects of the Action

Under the ESA, “effects of the action” means the direct and indirect effects of an action on the species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action, that will be added to the environmental baseline (50 CFR 402.02). Indirect effects are those that are caused by the proposed action and are later in time, but are still reasonably certain to occur. During consultation, neither NMFS nor the action agency identified any interrelated or interdependent actions.

The ESA prohibits the unauthorized take of threatened or endangered species, and regulations define the term “take” to include harassment. Some ESA-listed marine mammals will be harassed as they respond to sound associated with the proposed action. The ESA does not define harassment and NMFS has no regulation defining harassment. The U.S. Fish and Wildlife Service has promulgated a regulation that defines harassment as “an intentional or negligent act

or omission which creates the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding, or sheltering" (50 CFR § 17.3). Under the MMPA, there is a definition of what is referred to as Level B harassment: "any act of pursuit, torment, or annoyance which … has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering but which does not have the potential to injure a marine mammal or marine mammal stock in the wild" (16 USC 1362(18)(A)(ii)). This opinion does not consider potential take associated with the proposed action for marine mammals. Take for marine mammals, including SRKWs and humpback whales, is defined and described in the incidental harassment authorization (IHA; NMFS 2017).

2.5.1 Effects of the Action on Listed Species

Pile Driving and Vessel Traffic

Listed Fish Species. Pile driving can cause levels of underwater sound high enough to injure or kill fish and alter behavior (Turnpenny and Nedwell 1994; Turnpenny et al., 1994; Popper 2003; Hastings and Popper 2005). Death from barotrauma can be instantaneous or delayed up to several days after exposure. High sound levels can also cause sublethal injuries. Fish suffering damage to hearing organs may suffer equilibrium problems, and may have a reduced ability to detect predators and prey (Turnpenny et al., 1994; Hastings et al., 1996). Hastings (2007) determined that a cumulative Sound Exposure Level (cSEL) as low as 183 decibels (dB; re: 1µPa2-sec) was sufficient to injure the non-auditory tissues of juvenile spot and pinfish with an estimated mass of 0.5 gram.

Adverse effects on survival and fitness can occur even in the absence of overt injury. Exposure to elevated noise levels can cause a temporary shift in hearing sensitivity (referred to as a temporary threshold shift), decreasing sensory capability for periods lasting from hours to days (Turnpenny et al., 1994; Hastings et al., 1996). Popper et al. (2005) found temporary threshold shifts in hearing sensitivity after exposure to cSELs as low as 184 dB. Temporary threshold shifts reduce the survival, growth, and reproduction of the affected fish by increasing the risk of predation and reducing foraging or spawning success.

Cumulative SEL is a measure of the sound energy integrated across all of the pile strikes. The Equal Energy Hypothesis, described by NMFS (2007), is used as a basis for calculating cSEL. The number of pile strikes is estimated per continuous work period. This approach defines a work period as all the pile driving between 12-hour breaks. NMFS uses the practical spreading model to calculate transmission loss. NMFS, USFWS, and WSDOT agreed to interim criteria to minimize potential impacts to fishes (FHWG 2008). The interim criteria identify the following thresholds for the onset of physical injury using peak sound pressure level (SPL) and cSEL:

- Peak SPL: levels at or above 206 dB from any hammer strike; and
- cSEL: levels at or above 187 dB for fish sizes of 2 grams or greater, or 183 dB for fish smaller than 2 grams.

For the project, WSF will drive 306 steel piles. Most piles will be installed with a vibratory hammer, which does not produce sound levels high enough to injure fish. Some piles will be proofed with an impact hammer to verify their load-bearing capacity. To reduce sound levels, WSF will use a bubble curtain on all impact proofed piles, where possible. Due to tidal fluctuations and the shallow location of many piles, a bubble curtain may not be feasible during all impact driving. Therefore, this analysis uses a conservative assumption of unattenuated impact pile noise for noise impact analysis.

Underwater SPLs from impact pile-driving at the Mukilteo Ferry Terminal will be temporary and intermittent, lasting up to 6 hours per work day when installing the steel piles with a vibratory hammer then proofing them with an impact hammer. Installation of 24-inch-diameter piles will take up to 23 days, and installation of 30-inch-diameter piles will take up to 10 days. All in-water work will occur between August 1 and February 15. All Puget Sound Chinook salmon and Puget Sound steelhead will be greater than 2 grams during this window, so the cSEL injury threshold for salmonids is 187 dB. Puget Sound/Georgia Basin yelloweye rockfish and Puget Sound/Georgia Basin bocaccio in the project area are likely pelagic larvae or possibly juvenile rockfish, and could be less than or greater than 2 grams. Therefore, the cSEL injury threshold for rockfish is 183 dB.

Previous studies on salmonid distribution in the nearshore indicate a low likelihood for Chinook salmon or steelhead presence during in-water work. In 2002, beach seines conducted along three sites in Mukilteo collected predominantly juvenile salmon (>99 percent), most of which were pink (*Oncorhynchus gorbuscha*) and chum (*O. keta*) (Williams et al., 2003). Three of the 25,018 fish caught during beach seining were Chinook salmon (Williams et al., 2003). Chinook salmon entered the area in low numbers beginning in late April, peaked in mid-May to early June, and continued in moderate to high numbers through mid-July. During 2001 and 2002, beach seining conducted in central Puget Sound by King County Department of Natural Resources captured only nine steelhead out of a total of approximately 34,000 juvenile salmonids (Brennan et al., 2004). Beach seine sampling in Bellingham Bay (north Puget Sound) also captured few steelhead (Lummi Nation, unpublished data). Enclosure netting and beach seining around the Port Townsend ferry terminal caught steelhead near the ferry terminal, but not underneath the terminal or adjacent piers (Southard et al., 2006).

Although there is some potential for in-water construction to overlap with the presence of larval or juvenile rockfish, in-water work will occur from August through February when larval and juvenile rockfish are less likely to be present. Yelloweye rockfish and adult bocaccio typically occupy deeper waters and are unlikely to occur within the project area because of its shallow depth. In-water work will occur in depths up to 35 feet. Juvenile bocaccio occupy the nearshore of rocky habitats and macroalgae from March through September.

The REEF Environmental Education Foundation (REEF) database (2017) indicates that very low numbers of either adult or juvenile yelloweye rockfish have been observed in the Mukilteo vicinity (0.5 percent of all observations during 82 species and abundance surveys). No bocaccio rockfish were observed during these surveys. Juvenile bocaccio are often associated with macroalgae, especially kelps and sandy areas that support seagrasses, and may occur in the project area. Larval rockfish can occur within the project and action area, though they are readily

dispersed by currents after they are born, making the concentration or probability of larval presence in any one location extremely small (NMFS 2003). According to Greene and Godersky (2012), pelagic larvae presence in Puget Sound is seasonal, with the highest densities occurring between June and August.

NMFS cannot estimate the number of individuals that will experience adverse effects from underwater sound. Impact pile driving will occur episodically throughout the in-water work seasons. Furthermore, not all exposed individuals will experience adverse effects. Therefore, NMFS will use the physical and temporal extent of injurious levels of underwater sound to estimate the extent of effects to listed fish species.

As described above, WSF will use a vibratory hammer to install and an impact driver to proof 68 temporary, 24-inch-diameter steel piles to support construction of the overhead loading structure below MHHW; and 25 permanent 30-inch-diameter steel piles associated with the trestle structure below MHHW. NMFS estimates that the maximum sound levels for a single strike for driving the 24-inch-diameter steel piles will be 174 sound exposure level decibels (dB_{SEL}), 189 $dB_{RMS,}$ and 199 $dB_{PEAK.}$ NMFS estimates that the maximum sound levels for a single strike for driving the 30-inch-diameter steel piles will be 180 dB_{SEL}, 195 dB_{RMS}, and 206 peak decibel (dB_{PEAK}). Using these values with the estimated number of strikes per pile and up to three piles per day, NMFS calculated the distance at which fish will be subjected to cSELs greater than or equal to 187 dB (fish at 2 grams and larger) and 183 dB (fish less than 2 grams).

Assuming 300 strikes per pile for proofing during the impact pile-driving of the 24-inch-diameter steel piles, fish of 2 grams or larger could be subjected to injurious levels of underwater noise within 127 meters (417 feet), while fish less than 2 grams could be injured within 234 meters (768 feet) of the source (Table 3). For impact pile-driving of the 30-inch-diameter steel piles and assuming 300 strikes per pile, fish of 2 grams or larger could be injured within 318 meters (1,043 feet), while fish less than 2 grams could be subjected to injurious levels of underwater noise within 588 meters (1,929 feet) of the source (Table 3). For impact pile-driving of the 30-inch-diameter steel piles associated with the overhead loading structure, and assuming 3,000 strikes per pile, fish of 2 grams or larger could be subjected to injurious levels of underwater noise within 710 meters (2,329 feet), while fish less than 2 grams could be subjected to injurious levels of underwater noise within 1,000 meters (3,281) feet of the source (Table 3).

Table 3. Chinook salmon, steelhead, yelloweye rockfish, and bocaccio injury thresholds for impact pile driving.

Pile Size/Estimated Number of Strikes	Distance (m) to threshold			
	Onset of Physical Injury			Behavior
	Peak dB	cSEL dB*		RMS dB
		Fish ≥ 2g	Fish < 2g	
24-inch-diameter/300	10	127	234	3,981
30-inch-diameter/300	33	318	588	10,000
30-inch diameter/3,000	33	710	1,000	10,000

*Analysis assumes both adult and juvenile salmonids could be present.

g = gram

cSEL dB = cumulative Sound Exposure Level decibels

Peak dB = peak decibels

RMS dB = root mean square decibels

In summary, the low likelihood of occurrence of listed fish (Chinook salmon, steelhead, yelloweye rockfish, and bocaccio), in combination with the small area where sounds levels are likely to rise above the harm threshold, support the low probability that listed fish species will be harmed by pile-driving activity. Of the 306 temporary and permanent piles installed below MHHW for the project, only 3 will be 30-inch-diameter steel piles that require 3,000 strikes (and which produce sound levels injurious to listed fish species). While pile driving may have an adverse effect on listed fish species, the level of harm may differ by fish size and life cycle stage. Of the limited number of listed fish likely to occur in the area where sound produced by pile driving reaches injurious levels, fewer will be less than 2 grams or of a sensitive life cycle stage (planktonic larvae, juvenile < 2 grams) to be injured or killed.

Increased background noise has been shown to increase stress in humans (Hattis and Richardson 1980) and other mammals (Owen et al., 2004). Several studies support that the same is true for fish (Mueller 1980; Scholik and Yan 2002; Picciulin et al., 2010). Recreational boat noise diminished the ability of resident red-mouthed goby (*Gobius cruentatus*) to maintain its territory (Sebastianutto et al., 2011). Depending on speed and proximity to nests, boats caused spawning long-eared sunfish to abandon their nests for varying periods in order to find shelter (Mueller 1980). Xie et al. (2008) report that adult migrating salmon avoid vessels by swimming away. Graham and Cooke (2008) studied the effects of three boat noise disturbances (canoe paddling, trolling motor, and combustion engine [9.9 horsepower]) on the cardiac physiology of largemouth bass (*Micropterus salmonids*). Exposure to each of the treatments resulted in an increase in cardiac output in all fish, associated with a dramatic increase in heart rate and a slight decrease in stroke volume, with the most extreme response being to that of the combustion engine treatment (Graham and Cooke 2008). Recovery times were the least with canoe paddling (15 minutes) an overd the longest with the power engine (40 minutes). They postulate that these reactions demonstrate that fish experienced sublethal physiological disturbances in response to the noise propagated from recreational boating activities. Even though NMFS did not find studies exploring the physiological effects on salmon, it is reasonable to assume that juvenile and adult salmon, in addition to avoiding boats (Xie et al., 2008), experience sublethal physiological stress.

These documented behavioral and physiological responses to disturbance from boat noise divert time and energy from other fitness-enhancing activities such as feeding, avoiding predators, and defending territory. In Possession Sound, ferry traffic over the life of the project will likely disturb salmonids, cause them to at least temporarily leave the area, and cause them to experience sublethal physiological stress, which increases the likelihood of injury and being preyed upon. Different from a one-time disturbance related to construction noise, boat noise presents a chronic condition that will persist for the life of the project. Therefore, it is reasonable to expect that some fish will exhibit a behavioral response to noise that ultimately leads to their injury or death.

Southern Resident Killer Whales. NMFS has developed comprehensive guidance on sound levels that are likely to disrupt normal behaviors, or cause injury to the SRKWs. The technical guidance provides acoustic thresholds for onset of permanent threshold shift (PTS) and temporary threshold shifts (TTS) in marine mammal hearing for all sound sources. To develop these acoustic thresholds, NMFS compiled, interpreted, and synthesized best available information on the effects of anthropogenic sound on marine mammals' hearing, and developed a method for updating these levels through a systematic and transparent process.

For mid-frequency cetaceans (dolphins, toothed whales, beaked whales, bottlenose whales), the hearing range of 150 Hz to 160 kiloHertz (kHz) represents the generalized hearing range for the entire group as a composite (NMFS 2016c). Potential sound sources are divided into impulsive and non-impulsive sources. Impulsive sources produce sounds that are typically transient, brief (less than 1 second), broadband, and consist of high peak sound pressure with rapid rise time and rapid decay. Non-impulsive sources produce sounds that can be broadband, narrowband or tonal, brief or prolonged, continuous or intermittent, and typically do not have a high peak sound pressure with rise/decay time evident in impulsive sounds. For the purpose of this analysis, impact pile driving is characterized as an impulsive source and vibratory pile driving is characterized as a non-impulsive source.

WSF determined background noise levels at the Mukilteo Ferry Terminal are within the functional hearing range for the SRKW (122 dB_{RMS}) (Laughlin 2011). Therefore, NMFS used 122 dB_{RMS} as the threshold to determine the extent that project related noise exceeds ambient levels. Peak SEL is defined by the American National Standards Institute (ANSI) as incorporating frequency weighting, which is not the intent for this analysis. The subscript "flat" (peak SEL_{FLAT}) is included to indicate peak sound pressure should be flat-weighted or unweighted within the generalized hearing range. The cSEL is specific to the designated marine mammal auditory weighting function, and the recommended accumulation period is 24 hours. For mid-frequency cetaceans:

- The PTS peak SPLFLAT for impulsive sources is 230 dB.
- The PTS cSEL for impulsive sources is 185 dB.
- The PTS cSEL for non-impulsive sources is 198 dB.
- The TTS peak SPLFLAT for impulsive sources is 224 dB.
- The TTS cSEL is for impulsive sources is 170 dB.
- The TTS cSEL for non-impulsive sources is 178 dB.

The amount of noise generated during impact and vibratory pile driving, as well as the distance to injury and disturbance are calculated and described in the IHA (NMFS 2017).
Given the very high levels of anthropogenic disturbance from both construction and routine vessel traffic, SRKWs are extremely unlikely to approach the immediate vicinity of the terminal and, therefore, are extremely unlikely to be physically injured. WSF will monitor for marine mammals during all in-water activities according to the marine mammal monitoring plan for the project. WSF proposes to use a combination of land-based Protected Species Observers (PSOs) and monitoring boats with a PSO to monitor the Zone of Effect (ZOE) to prevent Level A injury and the Zone of Impact (ZOI) to prevent Level B harassment take. The ZOE and ZOI vary in size and shape depending on the type and size of pile being driven. NMFS expects WSF's monitoring will give WSF time to shut down pile-driving activities before SRKWs are exposed to levels of injurious noise from impact pile driving.

NMFS expects that SRKWs exposed to sound above 122 dB_{RMS} background level but below the injury threshold will respond in way similar to those documented for other mid-frequency hearing specialists. Southall et al. (2007) conducted a comprehensive literature review of the effects of sound on marine mammals. Behavioral responses in mid-frequency cetaceans from exposure to continuous sound waveforms can include moderate changes in speed of travel, direction, or dive profile; moderate to extended cessation or modification of vocal behavior; minor or moderate avoidance of the sound source; and change in group distribution (Southall et al., 2007).

SRKWs exposed to the sound of vibratory pile driving may be displaced from the action area where noise levels are above background level. They may choose to avoid the area in favor of less "noisy" water further away from the Mukilteo Ferry Terminal. These avoidance behaviors may result in lost forage opportunities in a portion of Puget Sound; however, there are alternate foraging areas available. Hanson et al. (2010) found only 6 to 14 percent of Chinook salmon eaten by SRKWs in the summer were from Puget Sound, and the Chinook salmon in the mid- and south-Puget Sound are a fraction of the Chinook salmon in Puget Sound. Therefore, the behavioral responses to increased noise from the pile driving and removal will not reduce the reproductive success or increase the risk of physical injury or death for any individual SRKW.

WSF will use tugs and barges to construct the project. These vessels are slow moving, follow a predictable course, and do not target whales. Marine mammal observers will be present during all in-water activities and will cease in-water activities when killer whales enter the ZOI. Therefore, vessel strikes are extremely unlikely and any potential encounters with SRKWs are expected to be sporadic and transitory in nature.

Humpback Whale. NMFS has developed comprehensive guidance on sound levels that are likely to disrupt normal behaviors, or cause injury to humpback whales. The technical guidance provides acoustic thresholds for onset of PTS and TTS in marine mammal hearing for all sound sources, as described above for SRKWs. For low-frequency cetaceans (baleen), the hearing range of 7 Hz to 35 kHz represents the generalized hearing range for the entire group as a composite (NMFS 2016c). Potential sound sources are divided into impulsive and non-impulsive sources.

Laughlin (2011) reported background noise levels at the Mukilteo Ferry terminal within the functional hearing range for humpback whales to be 124 dB_{RMS}. Therefore, NMFS used 124 dB_{RMS} as the threshold for this analysis. For low-frequency cetaceans:

- The PTS peak SPL_{FLAT} for impulsive sources is 219 dB.
- The PTS cSEL for impulsive sources is 183 dB.
- The PTS cSEL for non-impulsive sources is 199 dB.
- The TTS peak SPL_{FLAT} for impulsive sources is 213 dB.
- The TTS cSEL is for impulsive sources is 168 dB.
- The TTS cSEL for non-impulsive sources is 179 dB.

The amount of noise generated during impact and vibratory pile driving, as well as the distance to injury and disturbance, are calculated and described in the IHA (NMFS 2017).

Humpback whales use the action area, but their occurrence there is relatively uncommon. Of the low numbers that occur in the action area, the DPS from which those individuals are likely to originate is extrapolated from their occurrence off the state of Washington and southern British Columbia. A very small proportion (5.2 percent) of foraging humpback whales are expected to originate from the endangered Central America DPS, and the majority of humpback whales is expected to originate from the threatened Mexico DPS (41.9 percent) or the non-listed Hawaii DPS (52.9 percent). Based on a 95 percent confidence interval and in order to afford greater protection to the endangered DPS, NMFS applies a precautionary factor and assumes presence at the following percentages in Washington State waters:

Feeding Areas	**Central American DPS (E)**	**Mexico DPS (T)**
Washington/SBC)	15%	42%

There are no studies that document the response of low-frequency sound specialists to pile driving. Humpback whales exposed to sound from the proposed pile driving are unlikely to detect the physical presence of pile-driving machinery. For this reason, NMFS concludes that non-pulse sound sources are most likely to illicit a response from nearby humpback whales (Malme et al. 1983, 1984, and 1986). These studies documented responses ranging from slight deviation in course and deflection around the sound (migrating whales) to avoidance of the area (feeding whales). Therefore, NMFS anticipates that if humpback whales are exposed to sound from the vibratory pile driving in the project vicinity, they may respond by either changing course to deflect around the sound (migrating whales) or by avoiding the area (feeding whales).

The noise of impact and vibratory pile driving may disrupt the feeding behavior of humpback whales that may occur in Possession Sound. Similar to SRKWs, there are alternate foraging areas available throughout Puget Sound, and the short delays to migration are unlikely to cause a significant increase in an individual’s energy budget. Therefore, the effects are anticipated to be short-term and will not reduce the reproductive success or increase the risk of injury or mortality for any individual humpback whale.

WSF will use tugs and barges to construct the project. These vessels are slow moving, follow a predictable course, and do not target whales. Therefore, vessel strikes are extremely unlikely and

any potential encounters with humpback whales are expected to be sporadic and transitory in nature.

Water Quality – Turbidity

Turbidity plumes from disturbed sediments exceed baseline water quality conditions up to 150 feet from the source. The impacts of pile installation and removal are temporary and will settle within several minutes.

When exposed to increased suspended sediment in the water column, fish, particularly juvenile Chinook salmon that may occupy nearshore habitats, can experience gill abrasion and other effects that compromise fish health (Robertson et al. 2006). Turbid water can mask fish from predators but it can also hinder the fish from foraging in the plume. Instead, the fish may avoid the area until water quality returns to the baseline conditions. The in-water work will occur between August 1 and February 15. Although Chinook salmon are present in the area beginning in late April and are present through mid-July, some juvenile Chinook salmon may still be present and exposed to elevated turbidity near the in-water work areas early in the work window. They are expected to disperse from the action area later in the summer and into winter when fewer individuals will be exposed. Steelhead, yelloweye rockfish, and bocaccio are less likely to be present in the action area but would be similarly impacted if present during in-water work.

SRKWs and humpback whales will not be present in the nearshore where pile driving activities will create increased turbidity. If SRKWs or humpback whales are seen in the vicinity, all in-water activity will cease until the whales have moved beyond the ZOI.

Water Quality - Contaminants

The existing terminal and fishing pier are supported by a total of 290 creosote-treated timber piles. PAHs associated with creosote-treated wood can contaminate surrounding sediment up to 2 meters from the pile (Evans et al. 2009). The removal of the creosote-treated piles can mobilize these PAHs into the surrounding water and sediments (Smith 2008; Parametrix 2011). The project will also release PAHs directly from creosote-treated timber during the demolition of the deck and if any of the piles break during removal (Parametrix 2011). The concentration of PAHs released into surface water rapidly dilutes. Smith (2008) reported concentrations of total PAHs of 101.8 micrograms per liter (µg/L) 30 seconds after creosote-pile removal and 22.7 µg/L 60 seconds after removal; however, PAH levels in the sediment after pile removal can remain high for 6 months or more (Smith 2008). Romberg (2005) found a major reduction in sediment PAH levels 3 years after pile removal contaminated an adjacent sediment cap.

There are two pathways for PAH exposure to listed fish species in the action area: direct uptake through the gills and dietary exposure (Lee and Dobbs 1972; Neff et al. 1976; Karrow et al. 1999; Varanasi et al. 1993; Meador et al. 2006; McCain et al. 1990; Roubal et al. 1977). 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, steelhead, yelloweye rockfish, and bocaccio prey include amphipods, copepods, and fish larvae. The prey species uptake PAHs from contaminated sediments; the PAHs bioaccumulate in their tissues and cause greater levels of contamination in predator fish species (Landrum and Scavia 1983;

Landrum et al. 1984; Neff 1982). Marine mammals similarly accumulate PAHs by feeding on contaminated fish, such as salmonids and rockfish. Other impacts due to suspended contaminants during creosote pile removal are unlikely to impact marine mammals. All in-water work will be suspended when marine mammals are in the area, and will not resume until after they vacate the area.

The primary effects of PAHs on listed fish are immunosuppression and reduced growth. Karrow et al. (1999) characterized the immunotoxicity of creosote to rainbow trout (*O. 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. Consumption of contaminated prey, rather than absorption from the water, probably represents the primary pathway of contamination in marine fishes, such as rockfish (West and O'Neill 1998). Physiological effects of PAH exposure on Puget Sound fish include liver cancer, reproductive impairment, reduced immune function, and suppressed growth (Johnson et al. et al., 2008).

Listed fish that currently use the habitat near the creosote-treated timber structure in the action area are likely to be exposed to PAHs. The magnitude of the exposure will greatly increase during the removal of these structures. Because PAHs are associated with sediments, NMFS expects increased PAHs in the water column to extend 150 feet from the structure. The removal of the creosote-treated timber will reduce listed-fish exposure to PAHs in the long term. Some of the listed fish exposed to PAHs from the proposed action will experience immunosuppression and reduced growth that, in some cases, will increase the risk of death.

Because they are shoreline-oriented and spend a greater amount of time within the action area, juvenile Chinook salmon will have the highest probability of exposure to PAHs; however, NMFS cannot discount the probability of adult Chinook salmon, adult and juvenile steelhead, juvenile yelloweye rockfish, and juvenile bocaccio exposure. NMFS cannot predict the number of Chinook salmon, steelhead, yelloweye rockfish, and bocaccio that will be exposed to PAHs. The numbers of each species within the action area varies from year to year. NMFS also cannot estimate the proportion of fish each year that will enter the impact zones. Therefore, NMFS will use the area within 150 feet of the creosote-treated timber structure demolition as a surrogate for the number of Chinook salmon, steelhead, yelloweye rockfish, and bocaccio affected.

Overwater Coverage

The project will construct four new structures with overwater coverage: the new transfer span (1,600 square feet), the new overhead loading structure (2,600 square feet), the new terminal building (2,464 square feet), and the fishing pier (3,455 square feet). However, the project will also remove three structures with overwater coverage. As part of the project, the Tank Farm pier (138,085 square feet) was removed during Phase 1. Following the construction of the new Mukilteo Ferry Terminal and fishing pier, the existing terminal (8,120 square feet) and fishing pier (2,000 square feet) will also be removed. Overall, the project (Phases I and II) will reduce overwater coverage by a net 139,086 square feet (3.2 acres).

Although the project will reduce the overall amount of overwater structure, the Mukilteo Ferry Terminal will remain along the shore for many years. Overwater structures cause delays in migration for Puget Sound Chinook salmon from disorientation, fish school dispersal (resulting in a loss of refugia), and altered migration routes around the structures (Simenstad et al., 1999). An implication of juvenile salmon swimming around the structure is that juveniles will temporarily utilize deeper habitat, thereby exposing them to increased piscivorous predation (Nightingale and Simenstad 2001). Typical piscivorous juvenile salmonid predators, such as flatfish, sculpin, and larger juvenile salmonids, being larger than their prey, generally avoid the shallowest nearshore waters that outmigrant juvenile salmonids prefer—especially in the earliest periods of their marine residency. When juvenile salmonids temporarily leave the relative safety of the shallow water, their risk of being preyed upon by other fish increases. 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 structure lengthens the salmonid migration route, which has been correlated with increased mortality. Migratory travel distance rather than travel time or migration velocity has been shown to have the greatest influence on survival of juvenile spring Chinook salmon migrating through the Snake River (Anderson et al., 2005). In summary, NMFS assumes that the increase in migratory path length from swimming around the overwater structures as well as the increased exposure to piscivorous predators in deeper water over the life of the project likely will result in proportionally increased juvenile Puget Sound Chinook mortality. Unlike salmonids, juvenile and adult rockfish behaviors (such as foraging and migration) and risk of predation are not known to be adversely impacted by artificial structures such as piers and docks (Love et al., 2002).

Finally, the presence of the structure slightly reduces production of benthic and epibenthic macroinvertebrates in the action area that juvenile Chinook salmon, steelhead, yelloweye rockfish, and bocaccio prey upon. This slight reduction in prey base is likely not large enough to cause physiological effects on listed fish.
In summary, we expect three main effects to result from the existence of the overwater structure: migration delays, increased predation, and reduced prey production. Assuming that these effects are proportional to the size of the structure, we expect an immediate slight decrease in effects of overwater coverage (i.e., increased production of benthic invertebrates and prey items in the footprint of the removed Tank Farm Pier) because of the reduced size of the proposed structure. The effects related to the proposed structure will continue longer into the future that effects from the removed structure would.

We expect the effects on fish related to the long-term habitat modification to be proportional to the extremely small amount of affected nearshore habitat. Thus, we do not expect these effects to be of a magnitude to significantly impact any population productivity or abundance.

Stormwater

As described above, WSF will add 0.8 acre of PGIS to the existing 8.1 acres of PGIS, for a total of 8.9 acres. WSF will treat stormwater through the development of nine bioretention facilities

and five modular wetland systems. Exposure to stormwater pollutants causes reduced growth, impaired migratory ability, and impaired reproduction in salmonids. The extent and severity of these effects varies depending on the extent, timing, and duration of the exposure, ambient water quality conditions, the species and life history stage exposed, pollutant toxicity, and synergistic effects with other contaminants (EPA 1980). The primary pollutants of concern in stormwater from road surfaces are total suspended solids (TSS), total zinc, dissolved zinc, total copper, and dissolved copper. Dissolved metals are particularly difficult to remove from stormwater.

WSF used the Highway Runoff Dilution and Loading (HI-RUN) model to predict the post-treatment annual pollutant loading, effluent concentration, and dilution zone dimensions. The HI-RUN model uses a statistical procedure called Monte Carlo simulation. Monte Carlo simulation is a method that estimates outcomes from a set of random variables by simulating a process numerous times and observing the outcomes. Using Monte Carlo simulation, the HI-RUN model calculates multiple model output scenarios by repeatedly sampling values for each input variable from computer-generated probability distributions. In this way, a probability distribution can be derived for the model output that indicates the predicted values that have a higher probability of occurrence. The probability of exceeding a specific threshold for detrimental effects also can be determined using this procedure. The results from the HI-RUN model provides a conservative estimate of project stormwater impacts. Pre- and post-project pollutant loads and concentrations for the discharged stormwater are shown in Table 4 and Table 5, respectively. The proposed project will also extend this lower level of water quality degradation from stormwater into the future.

Table 4. Pre- and post-project pollutant loads for the existing Park Avenue outfall and new outfall.

Outfall	Scenario	Median Pollutant Concentration (lb/year)				
		TSS	TCu	DCu	TZn	DZn
Park Avenue	Existing	611	0.16	0.042	0.963	0.295
	Proposed	56	0.048	0.03	0.23	0.15
	Difference	-555	-0.112	-0.012	-0.733	-0.145
	Percent Change	-90.8%	-70%	-28.6%	-76.1%	-49.2%
New Outfall	Existing	0	0	0	0	0
	Proposed	233	0.2	0.12	0.95	0.63
	Difference	+233	+0.2	+0.12	+0.95	+0.63
	Percent Change	NA	NA	NA	NA	NA

lb/year = pound per year

TSS = total suspended solids

TCu = total copper

DCu = dissolved copper

TZn = total zinc

DZn = dissolved zinc

NA = not applicable

Table 5. Pre- and post-project pollutant concentrations for the existing Park Avenue outfall and new outfall.

Outfall	Scenario	Median Pollutant Concentration (µg/L)				
		TSS	TCu	DCu	TZn	DZn
Park Avenue	Existing	543,780	140	40	860	260
	Proposed	56,270	50	30	230	160
	Percent Change	-89.7%	-64.3%	-25%	-73.3%	-38.5%
New Outfall	Existing	0	0	0	0	0
	Proposed	5,689	60	30	300	170
	Percent Change	NA	NA	NA	NA	NA

µg/L = micrograms per liter

TSS = total suspended solids

TCu = total copper

DCu = dissolved copper

TZn = total zinc

DZn = dissolved zinc

NA = not applicable

Stormwater from the new terminal facility will discharge to Possession Sound via two outfalls: an existing storm drain outfall within Park Avenue, and a new outfall to be installed east of the terminal building WSF used the CORMIX dilution model to estimate pollutant-dilution distances from the outfalls.

Dissolved copper and dissolved zinc are the constituents of greatest concern because they are prevalent in stormwater, they are biologically active at low concentrations, and they have adverse effects on salmonids (Sprague 1968; Sandahl et al., 2007). Increased copper and zinc loading presents two pathways for possible adverse effects: 1) direct exposure to water column pollutant concentrations in excess of biological effects thresholds and 2) indirect adverse effects resulting from the accumulation of pollutants in the environment over time, altered food web productivity, and possible dietary exposure.

Sub-lethal concentrations of dissolved copper have been shown to impair olfactory function in salmon in freshwater (Tierney et al., 2010). Baldwin et al. (2003) found that 30- to 60-minute exposures to a dissolved copper concentration of 2.3 µg/L over background level caused olfactory inhibition in coho salmon juveniles. Sandahl et al. (2007) found that a 3-hour exposure to a dissolved copper concentration of 2.0 µg/L caused olfactory inhibition in coho salmon juveniles. This copper-induced loss of smell leads to a reduction in predator avoidance (McIntyre et al., 2008). Further, fish have shown avoidance of sub-lethal levels of dissolved copper in freshwater (Giattina et al., 1982). While the avoidance behavior persisted in saltwater, no impairment of olfactory function in salmon has been found in saltwater at sub-lethal levels up to 50 g Cu/L (Sommers et al., 2016).

The toxicity of zinc is widely variable, dependent upon concurrent levels of calcium, magnesium, and sodium in the water column (De Schamphelaere and Janssen 2004). A review of zinc toxicity studies reveals effects including reduced growth, avoidance, reproduction impairment, increased respiration, decreased swimming ability, increased jaw and bronchial

abnormalities, hyperactivity, hyperglycemia, and reduced survival in freshwater fish (Eisler 1993). Juveniles are more sensitive to elevated zinc concentrations than adults (EPA 1987). Sprague (1968) documented avoidance in juvenile rainbow trout exposed to dissolved zinc concentrations of 5.6 µg/L over background levels.

Because they are shoreline-oriented and spend a greater amount of time within the action area, juvenile Chinook salmon will have the highest probability of exposure to stormwater pollutants from the two outfalls associated with the terminal facility. However, because the facility will discharge stormwater in perpetuity, NMFS cannot discount the probability of adult and juvenile steelhead and adult Chinook salmon exposure.

Of the 8.9 acres of PGIS, 7.8 acres will discharge to the outfalls and 1.1 acres will be infiltrated through the pervious concrete or treated by the bioretention facilities or modular wetland systems before infiltration. The existing Park Avenue outfall pipe and new outfall pipe will drain stormwater runoff directly into Possession Sound and will generate a plume of stormwater that will extend approximately 50 feet from outfall. Stormwater discharges may contain pollutants exceeding injury thresholds (dissolved zinc 5.6 µg/l over background concentrations and dissolved copper at 2.0 µg/l over background concentrations).

Juvenile Chinook salmon, steelhead, yelloweye rockfish, and bocaccio using the dilution zones during stormwater discharges will likely experience increased physiological stress, reduced feeding, impaired ability to detect predators, and behavior alterations. Because they are likely to migrate quickly through the action area, adult salmonids will experience less exposure to dissolved copper and dissolved zinc than juveniles. Yelloweye rockfish and bocaccio in the action area will likely be pelagic larvae or juveniles. The pelagic larvae will move quickly through the action area, whereas juvenile rockfish will be found near macroalgae, eelgrass, or large rock substrate. Adult Chinook salmon, adult steelhead, juvenile yelloweye rockfish, and juvenile bocaccio exposed to stormwater discharges will experience increased physiological stress and behavior alterations (e.g., altered migration routes).

NMFS cannot predict the number of Chinook salmon, steelhead, yelloweye rockfish, or bocaccio that will be exposed to the stormwater discharges, so NMFS will use the area within 50 feet of each outfall pipe as a habitat surrogate for the number of Chinook salmon, steelhead, yelloweye rockfish, and bocaccio affected. Stormwater discharges from the terminal facility will occur in perpetuity. The numbers of each species within the action area varies year to year as does the number of rain events that produce stormwater effluent. NMFS also cannot estimate the proportion of fish each year that will enter the dilution zones. Therefore, the distance from the outfalls where dissolved copper and dissolved zinc are above the biological effects thresholds serves to quantify the extent of affected Chinook salmon, steelhead, yelloweye rockfish, and bocaccio. Marine mammals are unlikely to be impacted by stormwater discharge because they are unlikely to be within 50 feet from the outfall pipe and thus exposed to stormwater effluent.

2.5.2 Effects on Critical Habitat

Puget Sound Chinook Salmon and Steelhead

The action area contains the nearshore marine PBF (PBF 5) of Puget Sound Chinook salmon and Puget Sound steelhead critical habitat. The essential elements of PBF 5 include areas free of obstruction and excessive predation with: 1) water quality and quantity conditions and foraging opportunities, including aquatic invertebrates and fishes, supporting growth and maturation; and 2) natural cover including submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, and side channels. The effects of the proposed action include beneficial effects on the free passage, water quality, and foraging elements of the nearshore marine PBF.

As described above, the Tank Farm pier was a significant obstruction to migrating juvenile Chinook salmon. Removal of the pier decreased total overwater coverage in the action area by 3.2 acres and substantially improved passage conditions within the action area.

The proposed removal of the creosote-treated timber structures (the existing terminal and fishing pier) will temporarily degrade water quality by releasing PAHs and other contaminants. It will also degrade water quality near the two outfalls in perpetuity from stormwater discharges. However, removing several tons of creosote-treated timber (290 timber piles) from the action area will incrementally improve water quality in the long term. Piles will be fully removed with a vibratory pile driver, if possible. If the pile is damaged or breaks during the removal process, the pile will be cut off at or below the mudline and capped with clean sediment. Water quality degradation from the removal of the creosote-treated timber structures will temporarily reduce prey quantity and quality.

Yelloweye Rockfish and Bocaccio

Nearshore critical habitat for listed rockfish has been designated in the project action area. Noise from impact pile driving will create a zone that is injurious to listed rockfish species. Critical habitat will be temporarily affected out to 3,280 feet from the source for up to 33 days.

The project will increase overwater cover by 8,519 square feet at the new Mukilteo Ferry Terminal. However, the project will remove 148,205 square feet of overwater cover by removing the Tank Farm (completed in Phase I) and the existing ferry terminal and fishing pier (Phase II). Therefore, the project will result in a net reduction of 139,686 square feet of overwater cover—a benefit to rockfish habitat.

Because the new ferry terminal will be seismically stabilized, it will persist into the future. Therefore, the overwater coverage will continue to reduce the quality of nearshore habitat into perpetuity.

Southern Resident Killer Whale

The proposed action will affect SRKW critical habitat. As described above, the proposed action will have short-term, construction-related as well as some long-term, operation-related adverse

effects on Chinook salmon, the primary prey of SRKWs. The adverse effects will likely lead to a very small reduction in numbers of Chinook salmon and increased concentrations of contaminants in Chinook salmon tissues.

Because of work timing, only a small percentage of the Puget Sound Chinook salmon ESU will be exposed to project-related, short-term adverse effects. Exposed individuals are expected to be in the action area for a very short time. The Puget Sound Chinook salmon ESU comprises a small percentage of the SRKW diet. Hanson et al. (2010) found only 6 to 14 percent of Chinook salmon eaten by SRKWs in the summer were from Puget Sound. Therefore, NMFS concludes that both the short-term adverse effects and the long-term beneficial effects on SRKW prey quantity and quality will be insignificant.

The sound from pile driving will interfere with SRKW passage within the action area. For example, exposed SRKWs are likely to redirect around the sound instead of passing through the area. As described above, the effects of the additional distance traveled is unlikely to cause a measureable increase in an individual's energy budget, and the effects would, therefore, be insignificant and temporary, limited to the immediate action area and the days in which there are pile-driving activities.

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). 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.

There are no reasonably foreseeable non-Federal activities within the action area that would affect listed species. Federal actions dominate current and future impacts in the action area because the vast majority of activities which may affect listed species in the action area will require an approval under the CWA. Future Federal actions will be subject to the section 7(a)(2) consultation under the ESA. As described in Section 2.4, Environmental Baseline, vessel traffic is the primary ongoing non-Federal activity in the action area. Specific threats from vessel traffic include the risk of strikes, behavioral disturbance, and acoustic masking. Protective regulations issued by NMFS in 2011 will minimize these threats in the action area (76 FR 20870).

Some continuing non-Federal activities are reasonably certain to contribute to climate effects within the action area. However, it is difficult to distinguish between the action area's future environmental conditions caused by global climate change and those caused by cumulative effects. Therefore, all relevant future climate-related environmental conditions in the action area are described in the environmental baseline (Section 2.4).

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 diminishes the value of designated or proposed critical habitat for the conservation of the species.

Critical Habitat of Listed Fishes

The status of the affected species is related to the status of critical habitat and baseline habitat conditions, which are systematically degraded. For rockfish in particular, numbers are depleted due to overharvesting. In general, baseline habitat conditions in the Puget Sound region have been degraded chiefly by human development. Relevant critical habitat modifications include the channelization and diking of rivers, increase of impervious surfaces in most watersheds, simplification of river deltas, elimination of small coastal bays, reduction in sediment supply due to beach armoring, and loss of tidal wetland (Fresh et al., 2011). In addition to beach armoring, other shoreline changes including OWS, marinas, roads, and railroads reduce marine nearshore habitat quality (Simenstad et al., 2011). The extent of these habitat changes significantly impairs several aspects of critical habitat and puts its function for listed salmonids at risk.

Climate change is likely to exacerbate several of the ongoing habitat issues, in particular increased summer temperatures and decreased summer flows in the freshwater environment and ocean acidification and sea level rise in the marine. While currently the net balance of shoreline armoring seems to be somewhat stable with new armoring being offset by restoration actions, sea level rise adds pressure to increase future armoring in Puget Sound. More shoreline armoring along with other infrastructure projects designed to protect against flooding will likely further reduce habitat quality for salmonids.

In summary, the status of the species' habitat is poor. The baseline conditions of habitat have been considerably degraded, mostly by human development. In addition to these already degraded conditions, the cumulative effects driven by development pressures from population growth and climate change will likely continue to adversely affect critical habitat and the species that depend on critical habitat functions. These cumulative effects will be related to commercial and residential construction and shoreline stabilization above the OHWM that currently is not regulated by the COE and thus does not have a Federal nexus. These habitat alterations may take place within critical habitat or influence critical habitat for listed species.

In this context, we consider the additional effects of the action on Puget Sound Chinook salmon and rockfish critical habitat including long-term effects on forage, natural cover, and safe passage. Critical habitat for Puget Sound steelhead has no marine component and thus is not affected. The effect of the proposed action on the forage and natural cover components of nearshore critical habitat on an ESU/DPS-wide scale are small. The existing site conditions along the marine shoreline are highly developed, providing minimal natural cover. The project will not degrade the amount of natural cover on the shore. Similarly, the project will not further degrade forage opportunities for Chinook salmon and rockfish. The persistence of the in-water structure

is reasonably likely to burden the function of the physical and biological features of habitat in the action area for many years. Overall, we believe the effects on critical habitat will be minor given the transitory use of the action area by listed fish species.
Even though the baseline is degraded and cumulative effects likely will continue to adversely affect critical habitat, the added adverse effects of the proposed action are too small on a designation scale to substantially reduce the conditions of critical habitat or preclude re-establishing properly functioning conditions. Overall, when added to the baseline and cumulative effects, the effects of the action on critical habitat do not significantly affect the conservation value of critical habitat at the designation scale.

Listed Fish Species

The current status of each of the four affected fish ESUs/DPSs is poor – three are threatened and one is endangered - which is among the reasons for their continued listing. Abundance of adult steelhead returning to nearly all Puget Sound rivers has fallen substantially since estimates began for many populations in the late 1970s and early 1980s. Listed rockfish abundances continue to decline with little–to-no sign of the effect of recent protective measures. In this context we consider the addition of the effects of the action on the listed species.

Puget Sound Chinook Salmon

Abundance across the Puget Sound Chinook ESU has generally decreased between 2010 and 2014, with only 6 small populations of 22 total populations showing a positive change in natural-origin spawner abundances. The August 1 and February 15 work window will greatly reduce exposure of Puget Sound Chinook juveniles to construction actions by ensuring work will occur when the likelihood of juvenile Chinook salmon presence along the nearshore in the action area is low. Few Puget Sound Chinook salmon will be exposed to small-scale, short-term injurious levels of underwater noise from the impact pile driving of the steel piles. For fish smaller than 2 grams, noise exceeding the threshold for onset of physical harm will extend up to 1,000 meters away from the impact pile driving for the 38 30-inch-diameter piles. For most of the piles, the threshold of onset of physical harm will extent only 588 meters. Within the work window, there will be only 33 days of impact pile driving, further limiting potential exposure. Thus, only a small percentage of juvenile Chinook salmon that use this habitat will be exposed and experience injurious levels of pile driving noise, described above. The low number of fish killed by pile-driving noise will reduce abundance of the cohorts that are present at the time of pile driving, but given the low numbers of fish injured or killed, the occurrence of this reduction is not expected to have an observable effect on the spatial structure, productivity, or diversity of the Puget Sound Chinook salmon ESU.

Puget Sound Chinook salmon will be exposed to short-term increased levels of PAHs in the water column during and immediately following the demolition of the creosote-treated timber structures. Puget Sound Chinook salmon will also be exposed to mid-term increased levels of PAHs in their prey items within 150 feet of the creosote-treated timber piles. Fish foraging in the area will be exposed to increased PAH levels in their prey from the start of construction to up to 3 years after construction is complete. The exposed fish will likely experience immunosuppression and reduced growth, which will likely lead to increased mortality; however,

the area subjected to increased PAHs is a very small fraction of the total nearshore habitat available to juvenile Puget Sound Chinook salmon, and prey items from this area will make up a very small percentage of any individual fish's diet. Thus, we expect few Chinook salmon to experience significant reduction in fitness. Furthermore, juvenile Chinook salmon from multiple populations use the action area. Therefore, we expect that the effects from PAH exposure will not have observable significant effect on the spatial structure, long-term abundance, or diversity on any single population or on the Puget Sound Chinook salmon ESU as a whole.

Puget Sound Chinook salmon will be intermittently exposed to pollutant levels elevated slightly above biologically relevant levels (dissolved zinc 5.6 μg/l over background concentrations and dissolved copper at 2.0 μg/l over background concentrations) from stormwater discharges in a very small portion of the action area. During stormwater discharges, juveniles using the dilution zones, within 50 feet of each of the two stormwater outfalls, will likely experience increased physiological stress, reduced feeding, impaired ability to detect predators, and behavior alterations. However, only a subset of the juveniles in any given year will migrate within the dilution zone of the outfalls. Furthermore, migration of Chinook salmon through the action area typically occurs from late spring to early fall, when rain events large enough to cause stormwater discharges are less frequent than during the winter. The average rainfall for Mukilteo in June, July, August, and September is 2.3 inches, 1.3 inches, 1.4 inches, and 2.1 inches, respectively (Weather Atlas 2017). The late-spring to early-fall rain events are equivalent to approximately 6 percent, 3.4 percent, 3.7 percent, and 5.6 percent of the rainfall for the year, showing that heavier rain events are less frequent during this season. During heavy rainfall events, only individuals within the dilution zones during stormwater discharges will be affected. Given the infrequency of rain events during the Chinook salmon migration times, the small area of the zones in which concentrations likely exceed biological relevant levels (limited to 50 feet from the outfall pipes) compared to the amount of habitat in the action area, the elevated pollutant levels from stormwater discharges will likely result in small numbers of fish experiencing reduced fitness (physiological stress, reduced feeding, behavior alterations) and death (impaired ability to detect predators). Thus, we expect the small reduction in abundance will not have a significant effect on the viable salmonid population (VSP) parameters of the ESU as a whole.

Removal of creosote-treated timber structures will improve habitat conditions within up to 150 feet of the removed structures. After the removal of the existing ferry terminal and fishing pier, approximately 7,775 tons of creosote-treated timber will have been removed, to the extent possible, from the marine environment through project Phases I and II. Piles that cannot be removed without breaking will be cut at or below the mudline and capped with clean sand. Overall, the project will remove 3.2 acres of overwater cover.

Creosote releases polycyclic aromatic hydrocarbons (PAHs) that harm biota through mutagenicity, carcinogenicity, phototoxicity, body deformities, and reproductive dysfunction (Manny and Kenaga 1991; Sibley et al., 2001; Evans et al., 2009). For example, deleterious effects on developing Pacific herring embryos include skeletal defects, ineffective swimming, and reduced hatch rates (Duncan et al., 2017). Total PAH concentrations generally decrease with distance from creosote-treated piles, and can approach background levels at 2 meters from the pile (Evans et al., 2009; Duncan et al., 2017). PAH exposure harms listed fish directly through reduced growth, reproductive impairment, morphological deformities, and resistance to diseases

(Johnson et al., 2008), and indirectly through reduction of prey. Creosote removal in Possession Sound will lead to a long-term increase in water quality in the immediate vicinity, and the structure removal will likely improve the ability of juvenile Chinook salmon to forage and migrate in the area. The removal of creosote structure will increase the amount of salmon prey items and will reduce the adverse impacts to Chinook salmon physiology, increasing abundance and productivity of Puget Sound Chinook salmon. Overall, the project will improve the VSP parameters of the ESU.

Puget Sound Steelhead

Juvenile Puget Sound steelhead are larger than Puget Sound Chinook salmon when they enter Puget Sound. They spend very little time in the nearshore areas and migrate rapidly to the ocean. This behavior greatly reduces the risk of exposure of juvenile steelhead to migratory delay and increased predation related to the existence of the overwater structure as well as water quality effects related to PAHs. While any individuals exposed to the stressors from this project will experience the same adverse effects as Puget Sound Chinook salmon, both the absolute number of individuals and the percentage of the population that will be exposed to project stressors will be lower. Any steelhead present in the action area are likely to be larger than 2 grams and can withstand greater noise levels and exposures to stormwater. Therefore, we expect the project to effect Puget Sound steelhead to a lesser degree than Puget Sound Chinook. Overall, the project will likely have an insignificant effect on the VSP parameters of the Puget Sound steelhead DPS.

Yelloweye Rockfish

The life stage of yelloweye rockfish that would be found in the action area is pelagic larvae (less than 2 grams) or juvenile rockfish (less than, equal to, or larger than 2 grams). During impact pile driving, noise will extend up to 1,000 meters from the activity; however, the impacts will be limited to 6 hours per day and spread over 33 days. Due to the low probability of yelloweye rockfish being in the action area and the limited timeframe during which pile driving will be completed, there is a low likelihood that larval or juvenile yelloweye rockfish will be exposed to injurious levels of sound associated with pile driving. There is also a low likelihood that larval or juvenile yelloweye rockfish will be exposed to and experience the sublethal effects of contaminants in the discharge area from the stormwater outfalls due to the limited number of yelloweye rockfish that will be in the action area and the small area that experiences elevated pollutant levels (dissolved zinc 5.6 μg/l over background concentrations and dissolved copper at 2.0 μg/l over background concentrations) in comparison to the size of the entire action area. While the few individuals exposed to the stressors from this project will experience adverse effects similar to those of Puget Sound Chinook salmon and Puget Sound steelhead, the number of individuals exposed to these stressors will be much lower.

Bocaccio

Like yelloweye rockfish, the bocaccio that would be found in the action area would be pelagic larvae (less than 2 grams) or juvenile rockfish (less than, equal to, or larger than 2 grams). Noise will extend up to 1,000 meters from the impact pile driving; however, there will be only 33 days of impact pile driving. This limits the already small probability that larval or juvenile bocaccio

will be exposed to or will experience the sublethal adverse effects of impact pile driving. There is also a low likelihood that larval or juvenile yelloweye rockfish will be exposed to and experience the sublethal effects of contaminants in the discharge area from the stormwater outfalls. While any individuals exposed to the project stressors will experience adverse effects similar to those of Puget Sound Chinook salmon, Puget Sound steelhead, and yelloweye rockfish, the number of individuals that will be exposed to these stressors will be low.

Southern Resident Killer Whales and Their Critical Habitat

Several factors identified in the recovery plan for the SRKW may be limiting recovery. These factors include quantity and quality of prey, toxic chemicals that accumulate in top predators, and disturbance from sound and vessels. Oil spills are also a risk factor. It is likely that multiple threats are acting together. Although it is clear which threat or threats are most significant to the survival and recovery of SRKWs, all of the threats are important to address.

The entire SRKW DPS is a single population of 85 whales. The effective population size of less than 30 whales is very small, and this, in combination with the absence of gene flow from other populations, may elevate the risk from inbreeding. A delisting criterion for the SRKW DPS is an average growth rate of 2.3 percent for 28 years (NMFS 2008). The current average annual growth rate of 0.3 percent, the risk of stochastic events, and genetic issues underscore the importance for the population to grow quickly.

A small number of SRKWs will be affected by pile-driving activities, and the most significant effect will be a behavioral response. The specific number of SRKWs affected by pile-driving activities is described in more detail in NMFS (2017). Behavioral responses can include changes in travel speed or direction, dive profile; moderate to extended cessation or modification of vocal behavior; minor or moderate avoidance of the sound source; and change in group distribution. Exposed killer whales may be displaced and precluded from foraging in the project vicinity, though there are alternate foraging areas available. Exposed individuals are also likely to alter their travel pattern around the sound rather than pass through the area. Any additional distance traveled is unlikely to cause a significant increase in an individual’s energy budget, and the effects would be short-term. The likely behavioral responses, even considering potential for repeat exposures of individual whales, are not anticipated to reduce the reproductive success or increase the risk of injury or mortality for any individual SRKW.

As described above in the effects to salmonids, the effects of the proposed action on prey quality or quantity (prey is a primary constituent element of designated critical habitat for SRKW) is low enough to not alter the viability of the fish species, and thus the effect will be insignificant as an effect of prey as an element of critical habitat. Thus, the minor reduction in prey abundance, and the additional effect of vessels associated with the proposed action are extremely unlikely to affect SRKWs. Effects of the action, when added to threats that are part of the environmental baseline and when cumulative effects are considered, will not appreciably reduce the species’ ability to survive and recover.

Humpback Whales

The current population of humpback whales in the North Pacific is approximately 18,000 to 21,000. Approximately 2,000 of those whales are part of the Washington/Oregon/California stock. Humpback whales are sighted with increasing frequency in the inland marine waters of Washington, primarily during the fall and spring months; however, occurrence in the action area is uncommon.

Based on the available information about foraging habits and space use of humpback whales in the inland waters of Washington, few whales are likely to pass through the action area to forage in the project vicinity. The potential exposure of humpback whales to underwater sound may elicit behavioral responses within the range of previously documented responses by low-frequency hearing specialists to non-pulse sound. Based on a review of these documented responses, NMFS concludes that humpback whales exposed to sound from the vibratory pile driving may respond either by changing their course to deflect around the sound (migrating whales) or by avoiding the area (feeding whales). Exposed humpback whales may be displaced and precluded from foraging in the project vicinity; however, there are alternate foraging areas available.

The low occurrence of humpback whales in the action area and seasonal absence of humpback whales from the action area make exposure to impacts of low likelihood. If individual whales enter the ZOI during project activities, the likely short-term behavioral responses, even considering potential for repeat exposures of individual whales, will not reduce the reproductive success or increase the risk of injury or mortality for any individual humpback whale. Effects of the action, in addition to threats that are part of the environmental baseline or cumulative effects will not appreciably reduce the species' ability to survive and recover.

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, any effects of interrelated and interdependent activities, and cumulative effects, it is NMFS' biological opinion that the proposed action is not likely to jeopardize the continued existence of Puget Sound Chinook salmon, Puget Sound steelhead, yelloweye rockfish, bocaccio, SRKW, or humpback whales nor destroy or adversely modify Puget Sound Chinook salmon, Puget Sound steelhead, yelloweye rockfish, bocaccio, and SRKW 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.

NMFS is not including an incidental take authorization for marine mammals at this time because the incidental take of marine mammals has not been authorized under section 101(a)(5) of the MMPA and/or its 1994 amendments. Following the issuance of such regulations or authorizations for marine mammals, NMFS may append this opinion to include an ITS for marine mammals.

2.9.1 Amount or Extent of Take

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

Effects of the action will coincide with the presence of Puget Sound Chinook salmon, Puget Sound steelhead, Puget Sound/Georgia Basin yelloweye rockfish, and Puget Sound/Georgia Basin bocaccio such that the incidental take is reasonable certain to occur. The take in the form of harm and harassment that is described below cannot be accurately quantified as a number of fish because NMFS cannot predict, using the best available science, the number of individuals of listed fish species that will be exposed to these stressors. Furthermore, even if NMFS could estimate that number, the manner in which each exposed individual responds to that exposure cannot be predicted.

In circumstances where NMFS cannot estimate the amount of individual fish that would be injured or killed by the effects of the proposed action, NMFS assesses the extent of take as an amount of modified habitat and exempts take based only on that extent (Table 6). This extent is readily observable and therefore suffices to trigger reinitiation of consultation, if exceeded and necessary (see H.R. Rep. No 97-567, 97th Cong., 2d Sess. 27 (1982).

NMFS cannot estimate the number of individuals that will experience adverse effects from underwater sound. Impact pile driving will occur episodically throughout the in-water work season. NMFS cannot predict the number of individual fish that will be exposed. Furthermore, not all exposed individuals will experience adverse effects. Therefore, NMFS will use the physical and temporal extent of injurious levels of underwater sound as a surrogate for the number of fish. Take in the form of harm and harassment of listed fish species from impact pile-driving noise (cSEL greater than 183 dB) is reasonably certain to occur for the area within 3,280 feet of the 306 new temporary and permanent steel piles (775.5 acres). This take will occur over 105 minutes, up to 3 times daily, over 33 days.

Table 6. Take summary.

Species	Life Stage	Type of Take	Description of Take Mechanism	Maximum Numbers Affected or Area Affected[1]
Puget Sound Chinook salmon	Juvenile	Harm	Exposure to cSEL above harm threshold.	Underwater noise over 775.5 acres of nearshore habitat will rise to levels of harm.
			Short-term exposure to contaminants.	4.76 acres of nearshore habitat will be temporarily degraded during creosote pile removal.
			Long-term habitat modification that reduces fitness and survival.	0.23 acre of nearshore habitat will be degraded by overwater structure for the expected life of the structures.
			Exposure to pollutant concentrations above baseline.	0.18 acre of nearshore habitat will be degraded by stormwater plume discharge from outfall pipes.
Puget Sound steelhead	Juvenile	Harm	Exposure to cSEL above harm threshold.	Underwater noise over 775.5 acres of nearshore habitat will rise to levels of harm.
			Short-term exposure to contaminants.	4.76 acres of nearshore habitat will be temporarily degraded during creosote pile removal.
			Long-term habitat modification that reduces fitness and survival.	0.23 acre of nearshore habitat will be degraded by overwater structure for the expected life of the structures.
			Exposure to pollutant concentrations above baseline.	0.18 acre of nearshore habitat will be degraded by stormwater plume discharge from outfall pipes.
Yelloweye rockfish	Planktonic larvae/ Juvenile	Harm	Exposure to cSEL above harm threshold.	Underwater noise over 775.5 acres of nearshore habitat will rise to levels of harm.
			Short-term exposure to contaminants.	4.76 acres of nearshore habitat will be temporarily degraded during creosote pile removal.
			Long-term habitat modification that reduces fitness and survival.	0.23 acre of nearshore habitat will be degraded by overwater structure for the expected life of the structures.
			Exposure to pollutant concentrations above baseline.	0.18 acre of nearshore habitat will be degraded by stormwater plume discharge from outfall pipes.
Bocaccio	Planktonic larvae/ Juvenile	Harm	Exposure to cSEL above harm threshold.	Underwater noise over 775.5 acres of nearshore habitat will rise to levels of harm.
			Short-term exposure to contaminants.	4.76 acres of nearshore habitat will be temporarily degraded during creosote pile removal.
			Long-term habitat modification that reduces fitness and survival.	0.23 acre of nearshore habitat will be degraded by overwater structure for the expected life of the structures.
			Exposure to pollutant concentrations above baseline.	0.18 acre of nearshore habitat will be degraded by stormwater plume discharge from outfall pipes.

[1] Puget Sound salmonid abundances are usually measured per year class; thus, the impacts are provided on annual abundance. As rockfish are long-living species, their abundance is measured as standing stock and the impact is expressed over the total duration of the permit.

NMFS cannot estimate the number of individuals that will experience adverse effects from exposure to contaminants. The numbers of each species within the action area varies from year to year. NMFS also cannot estimate the proportion of fish each year that will enter the impact zones. Therefore, NMFS will use the area within 150 feet of the creosote-treated timber structure demolition as a surrogate for the number of Chinook salmon, steelhead, yelloweye rockfish, and bocaccio affected. Take from contaminant exposure is reasonably certain to occur within 150 feet of the existing terminal (4.76 acres) over 40 days, the duration of pile removal.

NMFS cannot estimate the number of individuals that will experience adverse effects from the continued presence of overwater structures. Although the project will decrease the overall amount of overwater structure, the new structure will remain in the nearshore longer than the lifespan of the existing structure. NMFS also cannot estimate the proportion of fish each year that will be impacted by the presence of overwater structure. Therefore, NMFS will use the overall area of overwater structure as a surrogate for the number of Chinook salmon, steelhead, yelloweye rockfish, and bocaccio affected. Take from the continued presence of overwater structure is reasonably certain to occur within the 10,119-square-foot (0.23-acre) footprint of the new terminal location.

NMFS cannot predict the number of Chinook salmon, steelhead, yelloweye rockfish, or bocaccio that will be exposed to the stormwater discharges. Stormwater discharges will occur in perpetuity. The numbers of each species within the action area varies from year to year, as does the number of rain events that produce stormwater effluent. NMFS also cannot estimate the proportion of fish each year that will enter the dilution zones. Therefore, NMFS will use the distance from the outfalls where dissolved copper and dissolved zinc are above the biological effects thresholds described above as a surrogate for the number of Chinook salmon, steelhead, yelloweye rockfish, and bocaccio affected. Take from stormwater discharges exceeding injury thresholds (dissolved zinc 5.6 μg/l over background concentrations and dissolved copper at 2.0 μg/l over background concentrations) is reasonably certain to occur within 50 feet of the stormwater outfall pipes for dissolved zinc and dissolved copper, a total area of up to 7,850 square feet (0.18 acre).

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. The effect of take on Puget Sound Chinook salmon, Puget Sound steelhead, Puget Sound/Georgia Basin yelloweye rockfish, and Puget Sound/Georgia Basin bocaccio is described above in Sections 2.5 and 2.7, and will not jeopardize any of these species.

2.9.3 Reasonable and Prudent Measures

"Reasonable and prudent measures" (RPMs) are nondiscretionary measures that are necessary or appropriate to minimize the impact of the amount or extent of incidental take (50 CFR 402.02). These must be carried out for the exemption in section 7(o)(2) to apply.

The FTA shall minimize take of species Puget Sound Chinook salmon, Puget Sound steelhead, Puget Sound/Georgia Basin yelloweye rockfish, and Puget Sound/Georgia Basin bocaccio. These reasonable and prudent measures are necessary and appropriate to minimize the take of these species. The FTA shall:

1. minimize incidental take from impact-driving of steel piles;
2. minimize incidental take from contaminants; and
3. minimize incidental take from stormwater discharges.

2.9.4 Terms and Conditions

The terms and conditions described below are non-discretionary, and WSF or any applicant must comply with them in order to implement the RPMs (50 CFR 402.14). WSF 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. To implement RPM 1, the FTA shall:
    a) Conduct impact pile driving during low tides to the maximum extent practicable;
    b) Where possible, use a bubble curtain to attenuate sound from impact driving;
    c) When impact driving steel piles in water 3 or more feet deep, monitor underwater noise as described in Appendix F of the 2017 BA;
    d) Submit the results of PSO monitoring to NMFS; and
    e) Submit the results of the underwater noise monitoring to NMFS.

2. To implement RPM 2, FTA shall:
    a) Install floating booms during demolition and pile removal activities for the existing terminal pier;
    b) Equip the floating booms with absorbent pads to contain any oil sheens;
    c) Submit the following to NMFS: 1) the Dredge Material Management Program (DMMP) Compliance Sediment Characterization Report or equivalent, 2) the results of any other future contaminant sampling of marine sediments in the project area, 3) a turbidity monitoring report by April 1 following each construction season, 4) a contaminants monitoring report which will include the best management practices (BMPs) implemented to control the release of contaminates into marine waters and the disposition of creosote-treated wood and contaminated sediments; and
    d) Report any violations of the Washington Department of Fish and Wildlife's (WDFW) Hydraulic Project Approval or Ecology's requirements to NMFS.

3. To implement RPM 3, the FTA and WSDOT shall implement the programmatic approach to monitoring detailed in "Programmatic Monitoring Approach for Highway Stormwater Runoff in Support of Endangered Species Act (ESA) Section 7 Consultations." The sites selected for this programmatic monitoring approach shall be representative of conditions within the action area, including average daily traffic and seasonal and temporal variations in stormwater runoff quantity and quality. If the programmatic monitoring shows that the analysis performed for this project has

underestimated the end of pipe effluent concentrations or the size of the dilution zones, then the reinitiation provisions of this opinion may be triggered.

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

1. Use translucent structural glass or another light-penetrating surface for the deck of the new fishing pier; and
2. Use permeable pavement in all areas of post-project PGIS where the infiltrated stormwater would not encounter contaminated soils or ground water.

2.11 Reinitiation of Consultation

This concludes the reinitiation of formal consultation for the relocation of the Mukilteo Ferry Terminal.

As 50 CFR 402.16 states, reinitiation of formal consultation is required 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 agency action is subsequently modified in a manner that causes an effect on the listed species or critical habitat that was not considered in this 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

The applicable standard to find that a proposed action is not likely to adversely affect listed species or critical habitat is that all the effects of the action are expected to be discountable, insignificant, or completely beneficial. Beneficial effects are contemporaneous positive effects without any adverse effects to the species or critical habitat. Insignificant effects relate to the size of the impact and should never reach the scale where take occurs. Discountable effects are those extremely unlikely to occur.

Based on this analysis, NMFS concurs with FTA that the proposed action is not likely to adversely affect the subject listed species.

Green Sturgeon and Eulachon

The southern DPSs of green sturgeon and the southern DPS of Pacific eulachon have been documented in Puget Sound, but are uncommon. Puget Sound has a long history of commercial and recreational fishing and fishery-independent monitoring of other species that use habitats similar to those these species, but very few green sturgeon or eulachon have been observed. NMFS believes it is very unlikely that green sturgeon or eulachon will occur in the action area, and even more improbable that they will be exposed to impact pile driving, increased turbidity during in-water work, the increase in overwater structure, or perpetual stormwater discharge. Therefore, NMFS concludes that the effects to the southern DPS green sturgeon and southern DPS eulachon are discountable.

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 FTA and descriptions of EFH for Pacific Coast groundfish (Pacific Fishery Management Council [PFMC] 2016a), coastal pelagic species (PFMC 2016b), and Pacific Coast salmon (PFMC 2016c) 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 the Introduction to this document. The action area includes areas designated as EFH for groundfish, coastal pelagic species, and Pacific Coast salmon, but does not occur within a Habitat Area of Particular Concern.

3.2 Adverse Effects on Essential Fish Habitat

NMFS determined that the proposed action will have adverse effects to EFH designated for groundfish, coastal pelagic species, and Pacific Coast salmon, based on information provided in the BA and the analysis of effects presented in the ESA portion of this document. NMFS

determined that the proposed action will adversely affect EFH by temporarily elevating contaminant levels and permanently discharging stormwater.

The EFH within 3,280 feet of each steel pile (775.5 acres) will be affected by impact pile driving (cSEL greater than 187dB).

The EFH within 150 feet of the existing terminal (4.76 acres) will be affected by increased contaminants.

The EFH under the new structure (0.23 acre) will be affected by overwater structure.

The EFH located within 50 feet of the two stormwater outfall pipes will be adversely affected by stormwater discharges.

3.3 Essential Fish Habitat Conservation Recommendations

NMFS expects that full implementation of the following EFH conservation recommendations would protect, by avoiding or minimizing the adverse effects described in section 3.2 above, approximately 395 acres of designated EFH for groundfish, coastal pelagic species, and Pacific coast salmon. This calculation is based on the amount of habitat presumed to be disturbed by NMFS in the 2012 opinion (NMFS 2013). These conservation recommendations are a subset of the ESA terms and conditions. NMFS recommends that FTA:

1. Impact drive the steel piles during low tides to the maximum extent practicable;
2. Use a bubble curtain to attenuate sound from pile driving, when possible;
3. When impact driving steel piles in water 3 or more feet deep, monitor underwater noise as described in Appendix F of the 2017 BA;
4. Submit the results of the underwater noise monitoring to NMFS.
5. Install floating booms during demolition and pile removal activities for the existing terminal pier;
6. Equip the floating booms shall with absorbent pads to contain any oil sheens;
7. Submit the following to NMFS: 1) the DMMP Compliance Sediment Characterization Report or equivalent; 2) the results of any other future contaminant sampling of marine sediments in the project area; 3) a turbidity monitoring report by April 1 following each construction season; and 4) a contaminants monitoring report, which will include the BMPs implemented to control the release of contaminates into marine waters and the disposition of creosote-treated wood and contaminated sediments.
8. Report any violations of WDFW’s Hydraulic Project Approval or Ecology’s requirements to NMFS;
9. Implement the programmatic approach to monitoring detailed in “Programmatic Monitoring Approach for Highway Stormwater Runoff in Support of Endangered Species Act (ESA) Section 7 Consultations.” The sites selected for this programmatic monitoring approach shall be representative of conditions within the action area, including average daily traffic and seasonal and temporal variations in stormwater runoff quantity and quality. If the programmatic monitoring shows that the analysis performed for this project

has underestimated the end of pipe effluent concentrations or the size of the dilution zones, then the reinitiation provisions of this opinion may be triggered;
10. Use translucent structural glass or another light-penetrating surface for the deck of the new fishing pier; and
11. Use permeable pavement in all areas of post-project PGIS where the infiltrated stormwater would not encounter contaminated soils or ground water.

3.4 Statutory Response Requirement

As required by section 305(b)(4)(B) of the MSA, the FTA 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 FTA have agreed to use alternative timeframes for the FTA 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 FTA 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 FTA must reinitiate EFH consultation with NMFS if the proposed action is substantially revised in a way that may adversely affect EFH, or if new information becomes available that affects the basis for NMFS' EFH Conservation Recommendations (50 CFR 600.920(l)).

4. DATA QUALITY ACT DOCUMENTATION AND PRE-DISSEMINATION REVIEW

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

4.1 Utility

Utility principally refers to ensuring that the information contained in this consultation is helpful, serviceable, and beneficial to the intended users. The intended users of this opinion are NMFS,

FTA, and USACE. Other interested users could include WSDOT, the residents of the City of Mukilteo, Snohomish County, the State of Washington, and the general public. Individual copies of this opinion were provided to the above listed entities. 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 *a*nd 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

Anderson, J., E. Gurarie, and R. Zabel. 2005. Mean free-path length theory of predator-prey interactions: application to juvenile salmon migration. Ecological Modelling, 186:196-211.

Baldwin, D.H., J.F. Sandahl, J.S. Labenia, and N.L. Scholz. 2003. Sublethal effects of copper on coho salmon: Impacts on nonoverlapping receptor pathways in the peripheral olfactory nervous system. Environmental Toxicology and Chemistry, 22(10):2266–2274.

Barlow, J., J. Calambokidis, E.A. Falcone, C.S. Baker, A.M. Burdin, P.J. Clapham, J.K.B. Ford, C.M. Gabriele, R. LeDuc, D.K. Mattila, T.J. Quinn II, L. Rojas-Bracho, J.M. Straley, B.L. Taylor, J. Urbán R., P. Wade, D. Weller, B.H. Witteveen, and M. Yamaguchi. 2011. Humpback whale abundance in the North Pacific estimated by photographic capture-recapture with bias correction from simulation studies. Marine Mammal Science. 27:793-818.

Battin, J., M. W. Wiley, M. H. Ruckelshaus, R. N. Palmer, E. Korb, K. K. Bartz, and H. Imaki. 2007. Projected impacts of climate change on salmon habitat restoration. Proceedings of the National Academy of Sciences, USA 104(16):6720-6725.

Beamer, E., A. McBride, R. Henderson, and K. Wolf. 2003. The Importance of Non-Natal Pocket Estuaries in Skagit Bay to Wild Chinook Salmon: An Emerging Priority for Restoration. Skagit System Cooperative Research Department. La Conner, Washington. May 2003.

Beaudreau, A.H., and P.S. Levin. 2014. Advancing the use of local ecological knowledge for assessing data-poor species in coastal ecosystems. Ecological Applications, 24(2):244-256.

Bledsoe, L.J., D.A. Somerton, and C.M. Lynde. 1989. The Puget Sound runs of salmon: An examination of the changes in run size since 1896. Canadian Special Publication of Fisheries and Aquatic Sciences, 105:50-61.

Brennan, J.S., K.F. Higgins, J.R. Cordell, and V.A. Stamatiou. 2004. Juvenile salmonid composition, timing, distribution, and diet in marine nearshore waters of Central Puget Sound in 2001-2002. King County Department of Natural Resources and Parks, Seattle, Washington. 164 pp.

Burns, R. 1985. The shape and forms of Puget Sound. Published by Washington Sea Grant, and distributed by the University of Washington Press. 100 pages.

Calambokidis, J. E.A. Falcone, T.J. Quinn, A.M. Burdin, P.J. Clapham, J.K.B. Ford, C.M. Gabriele, R. LeDuc, D. Mattila, L. Rojas-Bracho, J.M. Straley, B.L. Taylor, J. Urbán R., D. Weller, B.H. Witteveen, M. Yamaguchi, A. Bendlin, D. Camacho, K. Flynn, A. Havron, J. Huggins, and N. Maloney. 2008. SPLASH: Structure of Populations, Levels of Abundance and Status of Humpback Whales in the North Pacific. Final report for Contract AB133F-03-RP- 00078 U.S. Department of Commerce Western Administrative Center, Seattle, Washington.

Calambokidis, J., E. Falcone, A. Douglas, L. Schlender, and J. Huggins. 2009. Photographic identification of humpback and blue whales off the U.S. West Coast: results and updated abundance estimates from 2008 field season. Southwest Fisheries Science Center. 18pp.

Calambokidis, J. 2013. Updated abundance estimates of blue and humpback whales off the US west coast incorporating photo-identifications from 2010 and 2011. Document PSRG-2013-13 presented to the Pacific Scientific Review Group, April 2013.

Croll, D.A., B.R. Tershy, A. Acevedo, and P. Levin. 1999. Marine vertebrates and low frequency sound. Technical Report for LFA EIS. Marine Mammal and Seabird Ecology Group, Institute of Marine Sciences, University of California, Santa Cruz, California.

De Schamphelaere, K.A. and C.R. Janssen. 2004. Bioavailability and chronic toxicity of zinc to juvenile rainbow trout (*Oncorhynchus mykiss*): comparison with other fish species and development of a biotic ligand model. Environmental Science and Technology, 38:6201-6209.

DNR. 2017. Nearshore Habitat Inventory. Department of Natural Resources. Accessed April 30, 2017. www.dnr.gov/programs-and-services/aquatic-science/nearshore-habitat-inventory

Drake, J.M., and B.D. Griffen. 2010. Early warning signals of extinction in deteriorating environments. Nature, 467(7314):456-459.

Drake, J., E.A. Berntson, J.M. Cope, R.G. Gustafson, E.E. Holmes, P.S. Levin, N. Tolimieri, R.S. Waples, S. Sogard, and G.D. Williams. 2010. Status review of five rockfish species in Puget Sound, Washington: Bocaccio (*Sebastes paucispinis*), canary rockfish (*S. pinniger*), yelloweye rockfish (*S. ruberrimus*), greenstriped rockfish (*S. elongatus*), and redstripe rockfish (*S. proriger*). U.S. Department of Commerce, NOAA Technical Memorandum, NMFS-NWFSC-108. 234 pages.

Duncan, D.L., M.G. Carls, S.D. Rick, and M.S. Stekoll. 2017. The toxicity of creosote-treated wood to Pacific herring embryos and characterization of polycyclic aromatic hydrocarbons near creosoted pilings in Juneau, Alaska. Environmental Toxicology and Chemistry, 36(5):1261-1269.

Ecology, Department of. 2010. Water Quality Assessment for Washington. Accessed March 20, 2012.

Eisler, R. 1993. Zinc hazards to fish, wildlife, and invertebrates: A synoptic review. U.S. Department of the Interior, Fish and Wildlife Service. Biological Report 10.106 pp.

EPA. 1980. Ambient Water Quality Criteria for Copper - 1980. U.S. Environmental Protection Agency, Publication 440/5-80-036, Washington, DC (October 1980). 162 pp.

EPA. 1987. Ambient Water Quality Criteria for Zinc - 1987. U.S. Environmental Protection Agency, Publication 440/5-87-003, Washington, DC (February 1987). 207 pp.

EPA. 2009. Approval of Washington State 2008 303(d) List. U.S. Environmental Protection Agency, Region 10. January 29, 2009.

Evans, M., K. Fazakas, J. Keating. 2009. Creosote Contamination in Sediments of the Grey Owl Marina in Prince Albert National Park, Saskatchewan, Canada. Water Air Soil Pollution. 201:161–184.

FHWG (Fisheries Habitat Working Group). 2008. Agreement in Principal for Interim Criteria for Injury to Fish from Pile Driving Activities. Memorandum of Agreement between NOAA Fisheries' Northwest and Southwest Regions; USFWS Regions 1 and 8; California, Washington, and Oregon Departments of Transportation; California Department of Fish and Game; and Federal Highways Administration. June 12, 2008.

Field, J.C., and S. Ralston. 2005. Spatial variability in rockfish (*Sebastes* spp.) recruitment events in the California Current System. Canadian Journal of Fisheries and Aquatic Sciences, 62:2199-2210.

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

Ford, J.K.B., and G.M. Ellis. 2006. Selective foraging by fish-eating killer whales *Orcinus orca* in British Columbia. Marine Ecology Progress Series, 316:185-199.

Ford, M.J., M.B. Hanson, J.A. Hempelmann, K.L. Ayres, C.K. Emmons, G.S. Schorr, R.W. Baird, K.C. Balcomb, S.K. Wasser, K.M. Parsons, and K. Balcomb-Bartok. 2011. Inferred paternity and male reproductive success in a killer whale (*Orcinus orca*) population. Journal of Heredity, 102: 537-553.

Fresh, K.L., M. Dethier, C. Simenstad, M. Logsdon, H. Shipman, C. Tanner, T Leschine, T. Mumfor, G. Gelfenbaum, R. Shuman, and J. Newton. 2011. Implications of observed anthropogenic changes to the nearshore ecosystems in Puget Sound. Prepared for the Puget Sound Nearshore Ecosystem Restoration Project. Technical Report 2011-03.

Friedwald, J. 2009. Causes and consequences of the movement of temperate reef fishes. PhD Dissertation, University of California, Santa Cruz, California. 89 pages.

Giattina, J.D., R.R. Garton, and D.G. Stevens. 1982. Avoidance of copper and nickel by rainbow trout as monitored by a computer-based data acquisition system. Transactions of the American Fisheries Society, 111:491-504.

Graham, A.L. and S.J. Cooke. 2008. The effects of noise disturbance from various recreational boating activities common to inland waters on the cardiac physiology of a freshwater fish, the largemouth bass (*Micropterus salmonids*). Aquatic Conservation: Marine and Freshwater Ecosystems, 18(7):1315-1324.

Greene, C., and A. Godersky. 2012. Larval rockfish in Puget Sound surface waters. NOAA Northwest Fisheries Science Center. December 27, 2012.

Hamilton, M.W. 2008. Evaluation of management systems for KSn fisheries and potential application to British Columbia’s inshore rockfish fishery. M.R.M Thesis, School of Resource and Environmental Management, Simon Fraser University, British Columbia.

Hanson, B., R.W. Baird, J.K.B. Ford, J. Hempelmann-Halos, D.M. Van Doornik, J.R. Candy, C. K. Emmons, G.S. Schorr, B. Gisborne, K.L. Ayres, S.K. Wasser, K.C. Balcomb, K. Balcomb-Bartok, J.G. Sneva and M.J. Ford. 2010. Species and stock identification of prey consumed by southern resident killer whales in their summer range. Endangered Species Research, 11:69-82.

Hard, J.J., J.M. Myers, M.J. Ford, R.G. Cope, G.R. Pess, R.S. Waples, G.A. Winans, B.A. Berejikian, F.W. Waknitz, P.B. Adams. P.A. Bisson, D.E. Campton, and R.R. Reisenbichler. 2007. Status review of Puget Sound steelhead (*Oncorhynchus mykiss*). U.S. Department of Commerce, NOAA Technical Memorandum, NMFS-NWFSC-81, 117 pp.

Hard, J.J., J.M. Myers, E.J. Connor, R.A. Hayman, R.G. Kope, G. Lucchetti, A.R. Marshall, G.R. Pess, and B.E. Thompson. 2015. Viability criteria for Puget Sound steelhead. U.S. Department of Commerce. NOAA Technical Memorandum NMFS-NWFSC-129. 367 pp.

Haring, D. 2002. Snohomish River Watershed Water Resource Inventory Area 7 – Final Report. Washington State Conservation Commission, December 2002.

Hastings, M.C. 2007. Calculation of SEL for Govoni et al. (2003, 2007) and Popper et al. (2007) studies. Report for Amendment to Project 15218, J&S Working Group, Applied Research Lab, Penn State University. 7 pp.

Hastings, M.C., and A.N. Popper. 2005. Effects of Sound on Fish. Prepared by Jones and Stokes for the California Department of Transportation, Sacramento, California (August 23, 2005). 82 pp.

Hastings, M.C., A.N. Popper, J.J. Finneran, and P. Lanford. 1996. Effects of low-frequency underwater sound on hair cells of the inner ear and lateral line of the teleost fish *Astronotus ocellatus*. Journal of the Acoustical Society of America, 99(3):1759-1766.

Hattis, D. and B. Richardson. 1980. Noise, general stress responses, and cardiovascular disease processes: Review and reassessment of hypothesized relationships. EPA 550/9-80-101, U.S. EPA, Washington DC.

Holt, M.M. 2008. Sound exposure and Southern Resident killer whales (*Orcinus orca*): A review of current knowledge and data gaps. NOAA Technical Memorandum NMFS-NWFSC-89, U.S. Department of Commerce, Seattle, Washington.

Hutchings, J.A., and J.D. Reynolds. 2004. Marine Fish Population Collapses: Consequences for Recovery and Extinction Risk. BioScience, 54(4):297-309.

ISAB (Independent Scientific Advisory Board). 2007. Climate change impacts on Columbia River basin fish and wildlife. Northwest Power and Conservation Council, Portland, Oregon.

Johnson, S.W., M.L. Murphy, and D.J. Csepp. 2003. Distribution, habitat, and behavior of rockfishes, *Sebastes* spp., in nearshore waters of southeastern Alaska: observations from a remotely operated vehicle. Environmental Biology of Fishes, 66:259-270.

Johnson, L.L., M.R. Arkoosh, C.F. Bravo, T.K. Collier, M.M. Krahn, J.P. Meador, M.S. Myers, W.L. Reichert, and J.E. Stein. 2008. The effects of polycyclic aromatic hydrocarbons in fish from Puget Sound, Washington. *In* The Toxicology of Fishes. Di Giulio, R.T., and D.E. Hinton. CRC Press, Boca Raton, Florida.

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

Krahn, M.M., M.J. Ford, W.F. Perrin, P.R. Wade, R.B. Angliss, M.B. Hanson, B.L. Taylor, G.M. Ylitalo, M.E. Dahlheim, J.E. Stein, and R.S. Waples. 2004. 2004 status review of Southern Resident killer whales (*Orcinus orca*) under the Endangered Species Act, U.S. Department of Commerce, NOAA Technical Memorandum, NMFS-NWFSC-62, 73p.

Landrum, P.F., B.J. Eadie, W.R. Faust, N.R. Morehead, and M.J. McCormick. 1984. Role of sediment in t e bioaccumulation of benzo(a)pyrene by the amphipod, *Pontoporeia hoyi*. Pages 799-812 *in* M. Cooke and A.J. Dennis (editors). Polynuclear aromatic hydrocarbons: mechanisms, methods and metabolism. Battelle Press, Columbus, Ohio.

Landrum, P.F., and D. Scavia. 1983. Influence of sediment on anthracene uptake, depuration, and biotransformation by the amphipod *Hyalella azteca*. Canadian Journal of Fishery and Aquatic Sciences, 40:298-305.

Laughlin, J. 2011. Underwater background noise levels at the Mukilteo Ferry Terminal. Washington State Department of Transportation.

Leaman, B.M. 1991. Reproductive styles and life-history variables relative to exploitation and management of *Sebastes* stocks. Environmental Biology of Fishes, 30:253-271.

Lee, R., and G. Dobbs. 1972. Uptake, Metabolism and Discharge of Polycyclic Aromatic Hydrocarbons by Marine Fish. Marine Biology. 17:201-208.

Love, M.S., M. Carr, and L. Haldorson. 1991. The ecology of substrate associated juveniles of the genus *Sebastes*. Environmental Biology of Fishes, 30:225-243.

Love, M.S., M. M. Yoklavich, and L. Thorsteinson. 2002. The rockfishes of the Northeast Pacific. University of California Press, Berkeley, California.

Malme, C.I., P.R. Miles, C.W. Clark, P. Tyack, and J.E. Bird. 1983. Investigations of the potential effects of underwater noise from petroleum industry activities on migrating gray whale behavior (BBN Report No. 5366; NTIS PB86-174174). Report from Bolt Beranek and Newman Inc. for U.S. Minerals Management Service, Anchorage, Alaska.

Malme, C.I., P.R. Miles, C.W. Clark, P. Tyack, and J.E. Bird. 1984. Investigations of the potential effects of underwater noise from petroleum industry activities on migrating gray whale behavior. Phase II: January 1984 migration (BBN Report No. 5586; NTIS PB86-218377). Report from Bolt Beranek and Newman Inc. for U.S. Minerals Management Service, Anchorage, Alaska.

Malme, C.I., B. Würsig, J.E. Bird, and P.L. Tyack. 1986 Behavioral responses of gray whales to industrial noise: Feeding observations and predictive modeling (BBN Report No. 6265, OCS Study MMS 88-0048; NTIS PB88-249008). NOAA Outer Continental Shelf Environmental Assessment Program, Final Reports of Principal Investigators, 56, 393-600.

Manny, B.A., and D. Kenaga. 1991. The Detroit River: Effects of contaminants and human activities on aquatic plants and animals and their habitats. Hydrobiologia, 219:269-279.

Mantua, N., I. Tohver, and A. F. Hamlet. 2009. Impacts of climate change on key aspects of freshwater salmon habitat in Washington State. *In*: Washington Climate Change Impacts Assessment: Evaluating Washington's future in a changing climate. Climate Impacts Group, University of Washington, Seattle, Washington.

McCain, B., D. Malins, M. Krahn, D. Brown, W. Gronlund, L. Moore, and S-L. Chan. 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.

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

McIntyre, J.K., D.H. Baldwin, J.P. Meador, and N.L. Scholz. 2008. Chemosensory deprivation in juvenile coho salmon exposed to dissolved copper under varying water chemistry conditions. Environmental Science and Technology, 42:6774-6775.

Meador, J., F. Sommers, G. Ylitalo, and C. Sloan. 2006. Altered growth and related physiological responses in juvenile Chinook salmon (*Oncorhynchus tshawytscha*) from dietary exposure to polycyclic aromatic hydrocarbons (PAHs). Canadian Journal of Fishery and Aquatic Sciences, 63: 2364–2376.

Moser, H.G., R.L. Charter, W. Watson, D.A. Ambrose, J.L. Butler, J. Charter, and E.M. Sandknop. 2000. Abundance and distribution of rockfish (*Sebastes*) larvae in the southern California Bight in relation to environmental conditions and fishery exploitation. California Cooperative Oceanic Fisheries Investigations Report, 41:132-147.

Mote, P.W., and E.P. Salathé. 2009. Future climate in the Pacific Northwest. In: Washington Climate Change Impacts Assessment: Evaluating Washington's future in a changing climate. Climate Impacts Group, University of Washington, Seattle, Washington.

Myers, J.M., J.J. Hard, E.J. Connor, R.A. Hayman, R.G. Kope, G. Lucchetti, A.R. Marshall, G.R. Pess, and B.E. Thompson. 2015. Identifying historical populations of steelhead within the Puget Sound distinct population segment U.S. Department of Commerce. NOAA Technical Memorandum NMFS-NWFSC-128. 149 pp.

Neff, J.M. 1982. Accumulation and release of polycyclic aromatic hydrocarbons from water, food, and sediment by marine animals. Pages 282-320 *in* N.L. Richards and B.L. Jackson (editors.). Symposium: carcinogenic polynuclear aromatic hydrocarbons n the marine environment. U.S. Environmental Protection Agency, Report 600/9-82-013.

Neff, J., B. Cox, D. Dixit, and J. Anderson. 1976. Accumulation and Release of Petroleum Derived Aromatic Hydrocarbons by Four Species of Marine Animals. Marine Biology. 38, 279-289.

Nightengale, B., and C. Simenstad. 2001. Overwater structures: Marine issues. Washington State Departments of Fish and Wildlife, Ecology, and Transportation, Olympia, Washington. 177 pp.

NOAA Fisheries. 2017. 2016 West Coast Entanglement Summary. March 2017. 7 pp. http://www.westcoast.fisheries.noaa.gov/mediacenter/WCR%202016%20Whale%20Entanglements_3-26-17_Final.pdf

NMFS. 1991. Recovery Plan for the Humpback Whale (*Megaptera novaeangliae*). Prepared by the Humpback Whale Recovery Team for the National Marine Fisheries Service, Silver Spring, Maryland. 105 pp.

NMFS. 2003. Alaska Fishery Science Center, processed report 2003-10. Marine protected areas and early life-history of fishes.

NMFS. 2007. Rationale for the Use of 187 dB Sound Exposure Level for Pile Driving Impacts Threshold. Unpublished memorandum. Seattle, Washington: National Oceanic and Atmospheric Administration, National Marine Fisheries Service.

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

NMFS. 2011a. Southern Resident Killer Whales (*Orcinus orca*) 5-year Status Review: Summary and Evaluation. National Marine Fisheries Service, Northwest Region, Seattle, Washington.

NMFS. 2011b. Final Environmental Assessment for New Regulations to Protect Killer Whales from Vessel Effects in Inland Waters of Washington. National Marine Fisheries Service, Northwest Region. November 2010.

NMFS. 2013. Endangered Species Act Section 7 Formal Consultation and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat consultation for Mukilteo Multimodal Project, Snohomish County, Washington. U.S. Department of Commerce, NOAA National Marine Fisheries Service. Seattle, Washington.

NMFS. 2016a. Draft Rockfish Recovery Plan: Puget Sound/Georgia Basin yelloweye rockfish (*Sebastes ruberrimus*) and bocaccio (*Sebastes paucispinis*). National Marine Fisheries Service. Seattle, Washington.

NMFS. 2016b. Southern Resident Killer Whales (*Orcinus orca*) 5-Year Review: Summary and Evaluation. National Marine Fisheries Service, West Coast Region, Seattle, Washington. December 2016.

NMFS. 2016c. Technical guidance for assessing the effects of anthropogenic sound on marine mammal hearing: Underwater acoustic thresholds for onset of permanent and temporary threshold shifts. U.S. Department of Commerce, NOAA, NOAA Technical Memorandum NMFS-OPR-55, 178 p.

NMFS. 2017. Takes of Marine Mammals Incidental to Specified Activities; Taking Marine Mammals Incidental to Mukilteo Multimodal Construction Project in Washington State. National Oceanic and Atmospheric Administration, RIN 0648-XF340).

NWFSC. 2015. Status review update for Pacific salmon and steelhead listed under the Endangered Species Act: Pacific Northwest. Northwest Fisheries Science Center. December 21, 2015.

Olesiuk, P.F., M.A. Bigg, and G.M. Ellis.1990. Life history and population dynamics of resident killer whales (*Orcinus orca*) in the coastal waters of British Columbia and Washington State. Report of the International Whaling Community (special issue).

Orca Network. 2017. Southern resident orca community demographics, composition of pods, births and deaths since 1998. Accessed April 19, 2017. www.orcanetwork.org/Main/index.php?categories_file=Births&20and%20Deaths.

Owen, M.A., R.R. Swaisgood, N.M. Czekala, K.J. Steinman, and D.G. Lindburg. 2004. Monitoring stress in captive giant pandas (*Ailuropoda melanoleuca*): Behavioral and hormonal responses to ambient noise. Zoo Biology, 23(2):147-164.

Pacunski, R., W. Palsson, and H.G. Greene. 2013. Estimating fish abundance and community composition on rocky habitats in the San Juan Islands using a small remotely operated vehicle. Washington Department of Fish and Wildlife, Fish Program. Olympia, Washington.

Palsson, W.A., T.S. Tsou, G.G. Bargmann, R.M. Buckley, J.E. West, M.L. Mills, Y.W. Cheng, and R.E. Pacunski. 2009. The biology and assessment of rockfishes in Puget Sound. FPT 09-04. Washington Department of Fish and Wildlife, Olympia, Washington.

Parametrix. 2011. Creosote Release from Cut/Broken Piles. Washington Department of Natural Resources. Olympia, Washington.

PFMC. 2016a. Pacific Coast Groundfish Fishery Management Plan: for the California, Oregon, and Washington Groundfish Fishery. Pacific Fishery Management Council, Portland, Oregon (August 2016).

PFMC. 2016b.Coastal Pelagic Species Fishery Management Plan as Amended through Amendment 15. Pacific Fishery Management Council, Portland, Oregon (February 2016).

PFMC. 2016c. Pacific Coast Salmon Fishery Management Plan: for commercial and recreational salmon fisheries off the coasts of Washington, Oregon, and California as revised through Amendment 19. Pacific Fishery Management Council, Portland, Oregon (March 2016).

PFMC (Pacific Fishery Management Council) and MEW (Model Evaluation Workgroup). 2008. Chinook Fishery Regulation Assessment Model (FRAM) Base Data Development v. 3.0 (Auxiliary Report to FRAM Technical Documentation). October 2008.

Picciulin, M., L. Sebastianutto, A. Codarin, A. Farina, and E.A. Ferrero. 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.

Popper, A.N. 2003. Effects of anthropogenic sounds on fishes. Fisheries 28(10): 24-31.

Popper, A.N., M.E. Smith, P.A. Cott, B.W. Hanna, A.O. MacGillivray, M.E. Austin, and D.A. Mann. 2005. Effects of exposure to seismic airgun use on hearing of three fish species. Journal of the Acoustical Society of America, 117:3958-3971.

Puget Sound Partnership. 2006. Puget Sound Agenda: Protecting and Restoring the Puget Sound Ecosystem by 2020.

Puget Sound Partnership. 2008. Puget Sound Action Agenda: Protecting and Restoring the Puget Sound Ecosystem by 2020. Updated May 27, 2009.

REEF. 2017. Distribution report for yelloweye rockfish (*Sebastes ruberrimus*) in PAC. REEF Environmental Education Foundation. Accessed April 30, 2017. http://www.reef.org/db/reports/dist/species/PAC/0064/1993-01-01/2017-04-30

Rice, C. 2004. 2003 Bellingham Bay juvenile Chinook tow-netting project field sampling and data summary. Report of the National Marine Fisheries Service to the Port of Bellingham, Bellingham, Washington.

Rice, C., E. Beamer, D. Lomax, R. Henderson, and G. Pess. 2001. Skagit Bay Tow-netting Pilot Study. Prepared by the Northwest Fisheries Science Center, NMFS and Skagit System Cooperative Research Program. 2001.

Rice, C, C. Greene, P. Moran, D. Teel, D. Kuligowski, R. Reisenbichler, E. Beamer, J. Karr, and K. Fresh. 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.

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

Romberg, P. 2005. Recontamination Sources at Three Sediment Caps in Seattle. Proceedings of the 2005 Puget Sound Georgia Basin Research Conference.

Roubal, W., T. Collier, and D. Malins. 1977. Accumulation and Metabolism of Carbon-14 Labeled Benzene, Naphthalene, and Anthracene by Young Coho Salmon. Archives of Environmental Contamination and Toxicology, 5:513-529.

Sandahl, J.F., D.H. Baldwin, J.J. Jenkins, and N.L. Scholz. 2007. A sensory system at the interface between urban stormwater runoff and salmon survival. Environmental Science and Technology, 41(8):2998–3004.

Scholik, A.R. and H.Y. Yan. 2002. Effects of noise on the auditory sensitivity of the bluegill sunfish, *Lepomis macrochirus*. Comparative Biochemistry and Physiology, 133:43-52.

Sebastianutto, L., M. Picciulin, M. Costanatini, and E. Ferrero. 2011. How boat noise affects an ecologically crucial behavior: the case of territoriality in *Gobius cruentatus* (Gobiidae). Environmental Biology and Fisheries, 92:207-213.

Sibley, P.K., M.L. Harris, K.T. Bestari, T.A. Steele, R.D. Robinson, R.W. Gensemer, K.E. Day, and K.R. Solomon. 2001. Response of zooplankton communities to liquid creosote in freshwater microcosms. Environmental Toxicology and Chemistry, 20:394-405.

Simenstad, C.A., B.J. Nightengale, R.M. Thom and D.K. Shreffer. 1999. Impacts of ferry terminals on juvenile salmon migrating along Puget Sound shorelines, Phase I: synthesis of state of knowledge. Final Research Report, Research Project T9903, Task A2, Washington State Department of Transportation, Washington State Transportation Center (TRAC), Seattle, WA. 116 pp + appendices.

Simenstad, C., M. Ramierz, J. Burke, M. Logsdon, H. Shipman, C. Tanner, J. Toft, B. Craig, C. Davis, J. Fung, P. Bloch, K. Fresh, D. Myers, E. Iverson, A. Bailey, P. Schlenger, C. Kiblinger, P. Myre, W. Gertsel, and A. MacLennan. 2011. Historical change of Puget Sound shorelines: Puget Sound Nearshore Ecosystem Project Change Analysis. Puget Sound Nearshore Report No. 2011-01. Published by Washington Department of Fish and Wildlife, Olympia, Washington, and U.S. Army Corps of Engineers, Seattle, Washington.

Sirovic, A., and D.A. Demer. 2009. Sounds of captive rockfishes. Copeia, 2009(3):502-509.

Smith, P. 2008. Risks to human health and estuarine ecology posed by pulling out creosote treated timber on oyster farms. Aquatic Toxicology, 86:287–298.

Sommers, E., E. Murdock, J. Labenia, and D. Baldwin. 2016. Effects of salinity on olfactory toxicity and behavioral responses of juvenile salmonids from copper. Aquatic Toxicology, 175:260-268.

Southall, B.L., A.E. Bowles, W.T. Ellison, J.J. Finneran, R.L. Gentry, C.R. Green, Jr., D. Kastak, D.R. Ketten, J.H. Miller, P.E. Nachtigall, W.J. Richardson, J.A. Thomas, and P.L. Tyack. 2007. Marine Mammal Noise Exposure Criteria: Initial Scientific Recommendations. 4 Criteria for Behavioral Disturbance, 33(4):446- 473.

Southard, S., R. Thom, G. William, J. Toft, C. May, G. McMichael, J. Vucelick, J. Newell, J. Southard. 2006. Impacts of Ferry Terminals on Juvenile Salmon Movement along Puget Sound Shorelines. Washington State Department of Transportation. Olympia, Washington.

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

Studebaker, R.S., K.N. Coxo, and T.J. Mulligan. 2009. Recent and historical spatial distributions of juvenile rockfish species in rocky intertidal tide pools, with emphasis on black rockfish. Transactions of the American Fisheries Society, 138:645-651.

Tolimieri, N., and P.S. Levin. 2005. The roles of fishing and climate in the population dynamics of bocaccio rockfish. Ecological Applications, 14:458-468.

Turnpenny, A., and J. Nedwell. 1994. The Effects on Marine Fish, Diving Mammals and Birds of Underwater Sound Generated by Seismic Surveys. Fawley Aquatic Research Laboratories Limited, Marine and Freshwater Biology Unit, Southampton, Hampshire, UK. 48 pp.

Turnpenny, A.W.H., K.P. Thatcher, and J.R. Nedwell. 1994. The effects on fish and other marine animals of high-level underwater sound. Fawley Aquatic Research Laboratory, Ltd., Report FRR 127/94, United Kingdom (October 1994). 79 pp.

USDC. 2014. Endangered and threatened wildlife; Final rule to revise the Code of Federal Regulations for species under the jurisdiction of the National Marine Fisheries Service. U.S Department of Commerce. Federal Register 79(71):20802-20817.

Varanasi, U., E. Casillas, M. Arkoosh, T. Hom, D. Misitano, D. Brown, S. Chan, T. Collier, B. McCain, and J. Stein. 1993. Contaminant Exposure and Associated Biological Effects in Juvenile Chinook Salmon (*Oncorhynchus tshawytscha*) from Urban and Nonurban Estuaries of Puget Sound. National Marine Fisheries Service Northwest Fisheries Science Center. Seattle, Washington.

Wallace, J.R. 2007. Update to the status of yelloweye rockfish (*Sebastes ruberrimus*) off the U.S. West Coast in 2007, Pacific Fishery Management Council, Portland, Oregon.

Ward, E., E. Holmes, and K. Balcomb. 2009. Quantifying the effects of prey abundance on killer whale reproduction. Journal of Applied Ecology, 46: 632-640.

Washington, P.M., R. Gowan, and D.H. Ito. 1978. A biological report on eight species of rockfish (*Sebastes* spp.) from Puget Sound, Washington. Northwest and Alaska Fisheries Center Processed Report, National Marine Fisheries Service, Seattle.

Weather Atlas. 2017. Monthly Weather Forecast and Climate, Mukilteo, Washington. Accessed May 22, 2017. <http://www.weather-atlas.com/en/washington-usa/mukilteo-climate>

Weis, L.J. 2004. The effects of San Juan County, Washington, marine protected areas on larval rockfish production. A thesis submitted in partial fulfillment of the requirements for the degree of Master of Science, University of Washington.

West, J.E. and S.M. O'Neill. 1998. Persistent pollutants and factors affecting their accumulation in rockfishes (*Sebastes* spp.) from Puget Sound, Washington. Puget Sound Water Quality Action Team, Olympia, Washington.

Willette, T.M. 2001. Foraging behavior of juvenile pink salmon (*Oncorhynchus gorbuscha*) and size-dependent predation risk. Fisheries Oceanography, 10(S1):110-131.

Williams, G.D., R.M. Thom, D.K. Shreffler, J.A. Southard, L.K. O'Rourke, S.L. Sargeant, V.I. Cullinan, R. Moursund, and M. Stamey. 2003. Assessing overwater structure-related predation risk on juvenile salmon: field observations and recommended protocols. Prepared for the Washington State Department of Transportation, DE-AC06-76RLO 1830.

Williams, G.D., P.S. Levin, and W.A. Palsson. 2010. Rockfish in Puget Sound: An ecological history of exploitation. Marine Policy, 34:1010-1020.

Xie, Y., C. Michielsens, A.P. Gray, F.J. Martens, and J.L. Boffrey. 2008. Observations of avoidance reactions of migrating salmon to a mobile survey vessel in a riverine environment. Canadian Journal of Fisheries and Aquatic Sciences, 65:2178-2190.