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

Refer to NMFS No:
WCRO-2020-00067

March 18, 2021

Michelle Walker
Corps of Engineers, Seattle District
Regulatory Branch CENWS-OD-RG
P.O. Box 3755
Seattle, Washington 98124-3755

Re: Endangered Species Act Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response for Emergency Repair of the Petrogas Pacific LLC Pier South Breasting Dolphin and Catwalk, Whatcom County, Washington, COE Number: NWS-2019-1054, Sixth Field HUC: 171100020500 – Strait of Georgia.

Dear Ms. Walker:

Thank you for your letter of January 16, 2020, requesting initiation of consultation with NOAA's National Marine Fisheries Service (NMFS) pursuant to Section 7 of the Endangered Species Act of 1973 (ESA) (16 U.S.C. 1531 et seq.) for U.S. Army Corps of Engineers (COE) emergency authorization of the Petrogas Pacific LLC South Breasting Dolphin and Catwalk Repair 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 (16 U.S.C. 1855(b)) for this action.

The enclosed document contains the biological opinion (Opinion) prepared by the NMFS pursuant to Section 7 of the ESA on the effects of the proposed action. In this Opinion, the NMFS concludes that the proposed action would adversely affect Puget Sound (PS) Chinook salmon and Puget Sound/Georgia Basin (PS/GB) bocaccio. The NMFS also concludes that the proposed action is likely to adversely affect designated critical habitat for PS Chinook salmon and PS/GB bocaccio but is not likely to result in the destruction or adverse modification of those designated critical habitats. This Opinion also documents our conclusion that the proposed action is not likely to adversely affect PS steelhead, PS/GB yelloweye rockfish and their designated critical habitat, and southern resident (SR) killer whales and their designated critical habitat. Impacts on critical habitat for PS steelhead was not considered in this opinion because it doesn't occur within the action area.

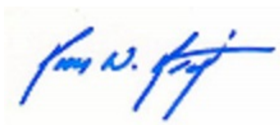
This Opinion includes an incidental take statement (ITS) that describes reasonable and prudent measures (RPMs) the NMFS considers necessary or appropriate to minimize the incidental take associated with this action, and sets forth nondiscretionary terms and conditions that the COE must comply with to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

Section 3 of this document includes our analysis of the action's likely effects on EFH pursuant to Section 305(b) of the MSA. Based on that analysis, the NMFS concluded that the action would adversely affect designated EFH for Pacific Coast Salmon, Pacific Coast Groundfish, and Coastal Pelagic Species. Therefore, we have provided 1 conservation recommendation that can be taken by the COE to avoid, minimize, or otherwise offset potential adverse effects on EFH.

Section 305(b) (4) (B) of the MSA requires Federal agencies to provide a detailed written response to NMFS within 30 days after receiving this recommendation. If the response is inconsistent with the EFH conservation recommendations, the COE must explain why the recommendations will not be followed, including the scientific justification for any disagreements over the effects of the action and recommendations. In response to increased oversight of overall EFH program effectiveness by the Office of Management and Budget, NMFS established a quarterly reporting requirement to determine how many conservation recommendations are provided as part of each EFH consultation and how many are adopted by the action agency. Therefore, we request that in your statutory reply to the EFH portion of this consultation you clearly identify the number of conservation recommendations accepted.

Please contact Donald Hubner in the North Puget Sound Branch of the Oregon/Washington Coastal Office at (206) 526-4359, or by electronic mail at Donald.Hubner@noaa.gov if you have any questions concerning this consultation, or if you require additional information.

Sincerely,



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

cc: Randel Perry, COE

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

Emergency Repair of the of the Petrogas Pacific LLC Pier South Breasting Dolphin and Catwalk, Whatcom County, Washington, (6th Field HUC 171100030700 –Strait of Georgia) (COE Number: NWS-2019-1054)

NMFS Consultation Number: WCRO-2020-00067

Action Agency: U.S. Army Corps of Engineers

Affected Species and NMFS' Determinations:

ESA-Listed Species	Status	Is Action Likely to Adversely Affect Species?	Is Action Likely To Jeopardize the Species?	Is Action Likely to Adversely Affect Critical Habitat?	Is Action Likely To Destroy or Adversely Modify Critical Habitat?
Chinook salmon (Oncorhynchus tshawytscha) Puget Sound (PS)	Threatened	Yes	No	Yes	No
Steelhead (O. mykiss) PS	Threatened	No	No	N/A	N/A
Bocaccio (Sebastes paucispinis) Puget Sound /Georgia Basin (PS/GB)	Endangered	Yes	No	Yes	No
Yelloweye rockfish (S. ruberrimus) PS/GB	Threatened	No	No	No	No
Killer whales (Orcinus orca) Southern resident (SR)	Endangered	No	No	No	No

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

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

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

Issued By:

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

Date: March 18, 2021

TABLE OF CONTENTS

1. Introduction 1
   - 1.1 Background 1
   - 1.2 Consultation History 1
   - 1.3 Federal Action 2
2. Endangered Species Act: Biological Opinion And Incidental Take Statement 5
   - 2.1 Analytical Approach 6
   - 2.2 Rangewide Status of the Species and Critical Habitat 7
   - 2.3 Action Area 18
   - 2.4 Environmental Baseline 19
   - 2.5 Effects of the Action 21
     - 2.5.1 Effects on Listed Species 22
     - 2.5.2 Effects on Critical Habitat 31
   - 2.6 Cumulative Effects 33
   - 2.7 Integration and Synthesis 33
     - 2.7.1 ESA-listed Species 34
     - 2.7.2 Critical Habitat 36
   - 2.8 Conclusion 38
   - 2.9 Incidental Take Statement 38
     - 2.9.1 Amount or Extent of Take 38
     - 2.9.2 Effect of the Take 41
     - 2.9.3 Reasonable and Prudent Measures 41
     - 2.9.4 Terms and Conditions 41
   - 2.10 Conservation Recommendations 42
   - 2.11 Reinitiation of Consultation 42
   - 2.12 "Not Likely to Adversely Affect" Determinations 42
     - 2.12.1 Effects on Listed Species 43
     - 2.12.2 Effects on Critical Habitat 45
3. Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response 47
   - 3.1 Essential Fish Habitat Affected by the Project 47
   - 3.2 Adverse Effects on Essential Fish Habitat 48
   - 3.3 Essential Fish Habitat Conservation Recommendations 49
   - 3.4 Statutory Response Requirement 49
   - 3.5 Supplemental Consultation 49
4. Data Quality Act Documentation and Pre-Dissemination Review 49
5. References 51

LIST OF ABREIVIATIONS

BE – Biological Evaluation
BMP – Best Management Practices
CFR – Code of Federal Regulations
COE – Corps of Engineers, U.S. Army
DQA – Data Quality Act
EF – Essential Feature
EFH – Essential Fish Habitat
ESA – Endangered Species Act
ESU – Evolutionarily Significant Unit
FR – Federal Register
FMP – Fishery Management Plan
GB – Georgia Basin
HAPC – Habitat Area of Particular Concern
HUC – Hydrologic Unit Code
ITS – Incidental Take Statement
mg/L – Milligrams per Liter
MHHW – Mean Higher High Water
MLLW – Mean Lower Low Water
MPG – Major Population Group
MSA – Magnuson-Stevens Fishery Conservation and Management Act
NMFS – National Marine Fisheries Service
NOAA – National Oceanic and Atmospheric Administration
NTU – Nephlometric Turbidity Units
PAH – Polycyclic Aromatic Hydrocarbons
PBF – Physical or Biological Feature
PCB – Polychlorinated Biphenyl
PCE – Primary Constituent Element
PFMC – Pacific Fishery Management Council
PS – Puget Sound
PSTRT – Puget Sound Technical Recovery Team
RL – Received Level
RMS – Root Mean Square
RPA – Reasonable and Prudent Alternative
RPM – Reasonable and Prudent Measure
SAV – Submerged Aquatic Vegetation
SEL – Sound Exposure Level
SL – Source Level
SR – Southern Resident (Killer Whales)
TSS – Total Suspended Solids
VSP – Viable Salmonid Population
WCR – West Coast Region (NMFS)
WDFW – Washington State Department of Fish and Wildlife
WDOE – Washington State Department of Ecology

1. INTRODUCTION

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

1.1 Background

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

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

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

1.2 Consultation History

On February 20, 2019, the NMFS completed formal consultation and with the U.S. Army Corps of Engineers (COE) for their authorization of the Petrogas Pacific LLC 5-Year Maintenance Program, which considered the effects of extending the useful life of the applicant's pier, in addition to construction-related effects (NMFS ref#: WCR-2018-9371).

On January 9, 2020, the COE informed the NMFS by e-mail that a December 15, 2019 ship allision had destroyed the Petrogas Pacific LLC Pier's south breasting dolphin and walkway (COE 2020a). That e-mail explained that the COE had issued emergency authorization on December 20, 2019 to allow the temporary installation of an anchored mooring buoy in response to the casualty, but that the applicant had subsequently requested emergency authorization to replace the lost dolphin and walkway. The COE asked if the emergency work could be covered under the 2019 BO for the applicant's 5-year pier maintenance program (WCR-2018-9371).

On January 10, 2020, the NMFS acknowledged the COE's inquiry, and requested additional information, which was provided the same day. On January 15, 2020, the NMFS acknowledged the emergency nature of the applicant's repair project, and committed to conduct an after-the-fact formal consultation for the COE's emergency authorization of the work. On January 15, 2020, the NMFS received an e-mail from the COE to request re-initiation of WCR-2018-9371.

However, on January 16, 2020, the NMFS received a letter from the COE requesting emergency formal consultation for their emergency authorization of the applicant's requested repair project

(COE 2020b). The letter included an enclosed memorandum for the services (MFS, COE 2020c), as well as a biological evaluation (BE), project drawings, and photographs for the proposed action (Petrogas 2020a – c). The same day, the COE rescinded their January 15, 2020 request to reinitiate WCR-2018-9371 (COE 2020d). That e-mail also stated that repairs would be completed before the February 15, 2020. The same day, the COE issued emergency authorization under Nationwide Permit 3 (NWP-3) for project work that could be completed July 16 through March 31 in any year the permit is valid (COE 2020e).

On March 20, 2020, the COE reported that an objection from the Lummi Nation had delayed the start of the project, necessitating the need to extend the work window beyond March 31 to mid-April. On March 23, 2020, the NMFS acknowledged that the requested extension would not substantially change expected effects on listed species (NMFS 2020). On April 9, 2020, the COE again requested to revise the work window to allow in-water work for pile driving and mooring buoy anchor removal through April 30, and allow barge-based work on overwater structures through May 30 (COE 2020f). On April 13, 2020, the NMFS agreed to the requested extension. Based on the expectation that no further changes to the project were likely, the NMFS initiated formal consultation for this action on April 9, 2020.

However, on August 14, 2020, the COE notified the NMFS of required project modifications that triggered a reinitiation of the consultation. Following the exchange of information between the applicant, the COE, and the NMFS, formal consultation was reinitiated on August 17, 2020.

No conference is required for this action concerning the September 19, 2019, proposed rulemaking by the NMFS to revise designated critical habitat for SR killer whales (84 FR 49214), because the proposed additional critical habitat is located well outside of the action area.

This Opinion is based on the information in the COE's consultation documents and additional information (COE 2020a-j; Petrogas 2020a-c, e, g, & h); recovery plans, status reviews, and critical habitat designations for ESA-listed PS Chinook salmon and PS/GB bocaccio; published and unpublished scientific information on the biology and ecology of those species; and relevant scientific and gray literature (see Literature Cited).

1.3 Federal Action

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

As described in the consultation history section, the COE initially issued emergency authorization, to allow Petrogas Pacific LLC (the applicant) to install a temporary mooring buoy at their pier to replace the mooring stability that was lost when their south breasting dolphin was destroyed by a ship allision. On December 24, 2019, the applicant's contractors installed a mooring buoy with three 400-foot long anchor chains, each with two 6,000-pound anchors at the distal ends. However, the mooring buoy turned out to be an untenable option for the location.

Following discussions with the NMFS, the COE issued emergency authorization to allow the applicant to remove the sunken south breasting dolphin and walkway and the temporary mooring buoy, and to install a new south breasting dolphin and walkway at the applicant's pier in the Strait of Georgia, northwest of the City of Bellingham, Washington (Figure 1).

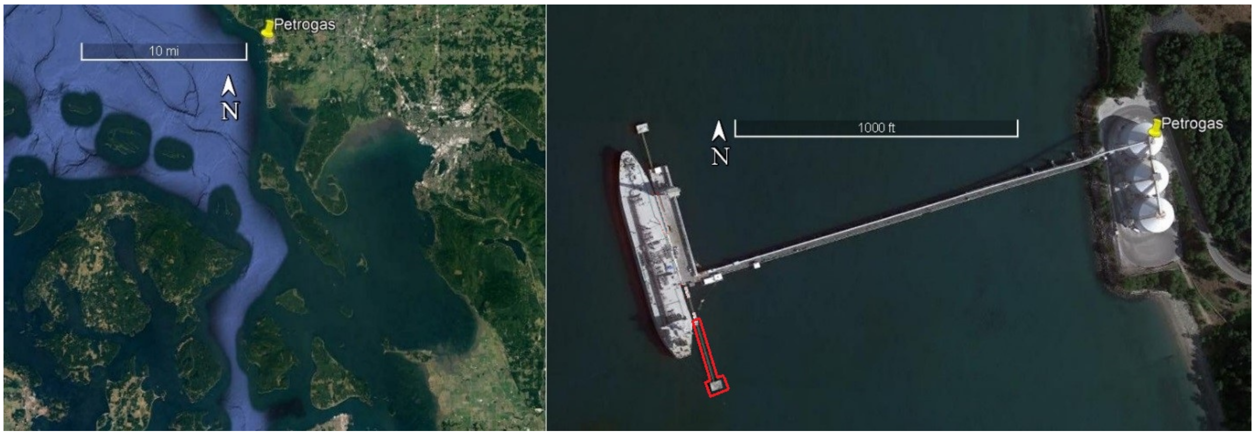


Figure 1. Google satellite photographs of the Petrogas Pacific LLC project site. The left image shows the pier's location in the Strait of Georgia, northwest of Bellingham, Washington. The right image shows the applicant's pier, with the south breasting dolphin and walkway outlined in red.

As described below, all project work has been completed. The applicant's contractors used barge-mounted heavy equipment, hand-held power tools, and divers to complete project components. When not moored against the pier, the barges used mooring spuds.

Between December 16, 2019 and February 26, 2020, the contractors used a barge-mounted crane and divers to install a temporary mooring buoy (described above) and to remove about 30 pieces of the 45 creosote-treated timber piles that supported the breasting dolphin and walkway, as well as some of the sunken debris from the upper portions of the dolphin and walkway, and to place the material on a debris barge for transfer to appropriate and approved upland disposal facilities.

Between April 4 and 15, 2020, the contractors performed 8 days of mixed vibratory and impact pile driving to install 9 30-inch diameter steel pipe piles. Seven of the new piles form the base of the new dolphin, and 2 piles support the new walkway. They conducted no pile driving on April 5, 9, 11, and 12, and employed only vibrator driving on April 4 and 10. The maximum total daily vibratory driving was 13 minutes of driving on April 4 and 14. The reported maximum number of total daily pile strikes was 3,299, which occurred on April 15 (Table 1). The contractors used a barge-mounted crane with American Piledriving Equipment (APE) 200-6 and APE-400 vibratory drivers, and an American Piledriving Equipment (APE) 12-42 diesel impact hammer. They employed cushion blocks, and a 6-ring, unenclosed bubble curtain device around each pile during impact pile driving (Delphis 2020). The applicant's contractors conducted marine mammal monitoring that started 20 minutes prior to the start, and continued during all pile driving to ensure that no marine mammals were within about 3,300 yards (3,000 m) of the project site during pile driving (Petrogas 2020a; 2020e).

Between April 16 and 30, 2020, the contractors performed 11 days of above-water work such as pile cutting and welding to install the dolphin cap, mooring hardware, and the walkway. They conducted lighter above-water work to install handrails, lights, electrical conduit, and a weather station. On April 29, 2020, they used a barge-mounted crane and divers to remove the temporary mooring buoy and its chains and anchors and to place them on a barge for transfer out of the action area. Construction work and temporary demobilization was finished the following day (Petrogas 2020e).

Table 1. Summary of individual pile driving events that were completed to replace the south breasting dolphin at the Petrogas Pier. Times are expressed using the 24-hour clock system, days of no pile driving are highlighted grey.

Date	Hours Since Last Driving	Start Day	End Day	Driving Times	Minutes of Vibratory	Pile Strikes
04/04/2020	N/A	1807	1835	1807-1835	13	N/A
04/05/2020	N/A	N/A	N/A	N/A	N/A	N/A
04/06/2020	42.6	1311	-	1311-1314	3	-
-	-	-	1818	1815-1818	-	141
04/07/2020	20.8	1504	-	1504-1508	11	-
-	-	-	1619	1601-1619	-	719
04/08/2020	20.9	1317	-	1317-1319	2	-
-	-	-	1519	1430-1519	-	1,141
04/09/2020	N/A	N/A	N/A	N/A	N/A	N/A
04/10/2020	45.5	1247	1317	1247-1317	3	N/A
04/11/2020	N/A	N/A	N/A	N/A	N/A	N/A
04/12/2020	N/A	N/A	N/A	N/A	N/A	N/A
04/13/2020	69.0	1014	-	1014-1115	-	1,414
-	-	-	-	1329-1348	7	-
-	-	-	1547	1452-1547	-	1,166
04/14/2020	17.0	0845	-	0845-0947	-	1,665
-	-	-	-	1503-1508	5	-
-	-	-	-	1742-1800	8	-
-	-	-	1905	1840-1905	-	1,440
04/15/20	13.1	0810	-	0810-0814	-	168
-	-	-	-	1123-1155	5	-
-	-	-	-	1232-1316	-	1,391
-	-	-	-	1553-1556	3	-
-	-	-	1740	1646-1740	-	1,740

No SR killer whales were observed over the entire period of pile driving. However, on April 4, 2 grey whales were observed within the 3,300-yard monitoring area for 20 minutes, along with an unidentified seal and 2 to 3 unidentified whales that were also observed, but outside of the area. Pile driving was halted for 30 minutes in response to the grey whales, and only resumed after they left the area. The only other marine mammal that was observed was a California sea lion that was observed within the monitoring area for about 15 minutes on April 14 during a period when no pile driving was being done (Petrogas 2020f).

Between August 13 and December 4, 2020, the contractors used divers and barge- and work platform-mounted equipment to complete the final debris removal (Petrogas 2020h). They first used a barge-mounted crane and divers to remove the remaining sunken piles and debris (with the exception of the 500-ton concrete dolphin cap), and to place the material on a debris barge for transfer to appropriate and approved upland disposal facilities. The divers also used 6-inch handheld pump dredges to relocate about 25 cubic yards of sediment from the top and around the edges of the dolphin cap. Monitoring verified that the turbidity plumes never exceeded 300 feet.

On September 4, 2020, the contractors used a barge-mounted crane with a vibratory driver to install 2 temporary 12-inch steel piles to support a temporary work platform. Each pile required about 25 minutes of vibratory driving to install. Marine mammal monitoring documented no ESA-listed marine mammals in the vicinity during pile driving. Marine mammal observations were limited to a harbor seal that approached no closer than (600 m) during pile driving, and a pair of harbor porpoises that were observed swimming past, about 2,800 m from the site between the two driving events (Petrogas 2020g).

After temporary platform installation, 12 days of in-water work with underwater wire saws was completed to cut the dolphin cap into 3 sections (blocks). That work was followed by about 14 more days of in-water work by divers using drills and other power tools to install lifting pad eyes into the 3 blocks. No work was conducted between October 23 and December 2, 2020. December 2 through 4, 2020, the contractors removed the 3 dolphin cap blocks with a barge-mounted crane and divers. They also removed the temporary work platform and piles. The piles were removed by direct pull, and took about 1 hour each to prep and pull. Final demobilization was also completed on December 4, 2020.

The NMFS also considered whether or not the proposed action would cause any other activities. However, the recent NMFS BO for the applicant's 5-year pier maintenance program (WCR-2018-9371) considered the effects of extending the life of the entire structure, including structure-related vessel operations, and the effects cause by the continued physical presence of the structure including the north and south breasting dolphins and their walkways. Therefore, the NMFS has concluded that this action would cause no other activities beyond the construction described above.

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

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

The COE determined that the proposed action is likely to adversely affect PS Chinook salmon and their designated critical habitat. The COE also determined that the proposed action is not likely to adversely affect PS steelhead and their critical habitat, PS/GB bocaccio and PS/GB yelloweye rockfish and designated critical habitat for both species, and SR killer whales and their designated critical habitat. Because the proposed action is likely to adversely affect listed species, the NMFS has proceeded with formal consultation. However, as described in Section 2.5, the NMFS determined that the proposed action is likely to adversely both affect PS Chinook salmon and PS/GB bocaccio, and designated critical habitat for both species. Our concurrence with the COE's "not likely to adversely affect" determinations for the remaining species and critical habitats is documented in Section 2.12, with the exception that critical habitat for PS steelhead doesn't occur within the action area and consequently was not considered in this opinion (Table 2).

Table 2. ESA-listed species and critical habitats that may be affected by the proposed action.

ESA-listed species and critical habitat likely to be adversely affected (LAA)				
Species	**Status**	**Species**	**Critical Habitat**	**Listed / CH Designated**
Chinook salmon (*Oncorhynchus tshawytscha*) Puget Sound	Threatened	LAA	LAA	06/28/05 (70 FR 37160) / 09/02/05 (70 FR 52630)
bocaccio (*Sebastes paucispinis*) Puget Sound/Georgia Basin	Endangered	LAA	LAA	04/28/10 (75 FR 22276) / 11/13/14 (79 FR 68041)
ESA-listed species and critical habitat not likely to be adversely affected (NLAA)				
Species	**Status**	**Species**	**Critical Habitat**	**Listed / CH Designated**
steelhead (*O. mykiss*) Puget Sound	Threatened	NLAA	N/A	05/11/07 (72 FR 26722) / 02/24/16 (81 FR 9252)
yelloweye rockfish (*S. ruberrimus*) PS/GB	Threatened	NLAA	NLAA	04/28/10 (75 FR 22276) / 11/13/14 (79 FR 68041)
killer whales (*Orcinus orca*) southern resident	Endangered	NLAA	NLAA	11/18/05 (70 FR 57565) / 11/29/06 (71 FR 69054)

LAA = likely to adversely affect NLAA = not likely to adversely affect N/A = not in the action area or not designated

2.1 Analytical Approach

This biological opinion includes both a jeopardy analysis and an adverse modification analysis. The jeopardy analysis relies upon the regulatory definition of "jeopardize the continued existence of" a listed species, which is "to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species" (50 CFR402.02). Therefore, the jeopardy analysis considers both survival and recovery of the species.

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

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

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

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

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

2.2 Rangewide Status of the Species and Critical Habitat

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

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

Listed Species

Viable Salmonid Population (VSP) Criteria

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

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

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

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

"Productivity" refers to the number of naturally-spawning adults produced per parent. When progeny replace or exceed the number of parents, a population is stable or increasing. When progeny fail to replace the number of parents, the population is in decline.
For species with multiple populations, we assess the status of the entire species based on the biological status of the constituent populations, using criteria for groups of populations, as described in recovery plans and guidance documents from technical recovery teams. Considerations for species viability include having multiple populations that are viable, ensuring that populations with unique life histories and phenotypes are viable, and that some viable populations are both widespread to avoid concurrent extinctions from mass catastrophes and spatially close to allow functioning as metapopulations (McElhany et al. 2000).

The summaries that follow describe the status of the ESA-listed species, and their designated critical habitats, that occur within the geographic area of this proposed action and are considered in this opinion. More detailed information on the status and trends of these listed resources, and their biology and ecology, are in the listing regulations and critical habitat designations published in the Federal Register.

Puget Sound (PS) Chinook Salmon

The PS Chinook salmon evolutionarily significant unit (ESU) was listed as threatened on June 28, 2005 (70 FR 37160). We adopted the recovery plan for this ESU in January 2007. The recovery plan consists of two documents: the Puget Sound salmon recovery plan (SSPS 2007) and the final supplement to the Shared Strategy's Puget Sound salmon recovery plan (NMFS 2006). The recovery plan adopts ESU and population level viability criteria recommended by the

Puget Sound Technical Recovery Team (PSTRT) (Ruckelshaus et al. 2002). The PSTRT's biological recovery criteria will be met when all of the following conditions are achieved:

- The viability status of all populations in the ESU is improved from current conditions, and when considered in the aggregate, persistence of the ESU is assured;
- Two to four Chinook salmon populations in each of the five biogeographical regions of the ESU achieve viability, depending on the historical biological characteristics and acceptable risk levels for populations within each region (Table 3);
- At least one population from each major genetic and life history group historically present within each of the five biogeographical regions is viable;
- Tributaries to Puget Sound not identified as primary freshwater habitat for any of the 22 identified populations are functioning in a manner that is sufficient to support an ESU-wide recovery scenario; Production of Chinook salmon from tributaries to Puget Sound not identified as primary freshwater habitat for any of the 22 identified populations occurs in a manner consistent with ESU recovery; and
- Populations that do not meet all the Viable Salmon Population (VSP) parameters are sustained to provide ecological functions and preserve options for ESU recovery.

Table 3. Extant PS Chinook salmon populations in each biogeographic region (Ruckelshaus *et al*. 2002, NWFSC 2015).

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

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

Hatchery-origin spawners are present in high fractions in most populations within the ESU, with the Whidbey Basin the only MPG with consistently high fractions of natural-origin spawners. Between 1990 and 2014, the fraction of natural-origin spawners has declined in many of the populations outside of the Skagit watershed (NWFSC 2015).

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

Chinook salmon are divided into two races, stream-types and ocean-types, based on the major juvenile development strategies. Stream-type Chinook salmon tend to rear in freshwater for a year or more before entering marine waters. Conversely, ocean-type juveniles tend to leave their natal streams early during their first year of life, and rear in estuarine waters as they transition into their marine life stage. Both stream- and ocean-type Chinook salmon are present, but ocean-type Chinook salmon predominate in Puget Sound populations.

Chinook salmon are further grouped into "runs" that are based on the timing of adults that return to freshwater. Early- or spring-run chinook salmon tend to enter freshwater as immature fish, migrate far upriver, and finally spawn in the late summer and early autumn. Late- or fall-run Chinook salmon enter freshwater at an advanced stage of maturity, move rapidly to their spawning areas, and spawn within a few days or weeks. Summer-run fish show intermediate characteristics of spring and fall runs, without the extensive delay in maturation exhibited by spring-run Chinook salmon. In Puget Sound, spring-run Chinook salmon tend to enter their natal rivers as early as March, but do not spawn until mid-August through September. Returning summer- and fall-run fish tend to enter the rivers early-June through early-September, with spawning occurring between early August and late-October.

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

Abundance and Productivity: Available data on total abundance since 1980 indicate that abundance trends have fluctuated between positive and negative for individual populations, but productivity remains low in most populations, and hatchery-origin spawners are present in high fractions in most populations outside of the Skagit watershed. Available data now show that most populations have declined in abundance over the past 7 to 10 years. Further, escapement levels for all populations remain well below the PSTRT planning ranges for recovery, and most populations are consistently below the spawner-recruit levels identified by the PSTRT as consistent with recovery (NWFSC 2015). The current information on abundance, productivity, spatial structure and diversity suggest that the Whidbey Basin MPG is at relatively low risk of extinction. The other four MPGs are considered to be at high risk of extinction due to low abundance and productivity (NWFSC 2015). The most recent 5-year status review concluded that the ESU should remain listed as threatened (NMFS 2017a).

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

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

PS Chinook Salmon within the Action Area: The PS Chinook salmon that are most likely to occur in the action area would be spring- and fall-run fish from the Nooksack River basin (WDFW 2020a). In the Nooksack River basin, between 1984 and 2016, the total abundance for PS Chinook salmon has fluctuated with the average trend being stable to slightly positive (NWFSC 2015) . However, abundance has been dominated by hatchery returns since 1996, with the proportion of natural-origin fish declining (NWFSC 2015; WDFW 2020b).

Between 1984 and 2016, escapement in the North Fork Nooksack River fluctuated between about 10 and 3,748 fish (1990 and 2002, respectively, WDFW 2020b). Between 1996 and 2016, natural-origin spawner abundance wavered between 37 and 401 fish, whereas hatchery-origin spawners exceeded 500 fish for 16 of those 20 years, and accounted for about 94% of the 3,748 fish in 2002. Total abundance was 922 fish in 2016, with natural-origin fish accounting for only 20% of the return. In the South Fork Nooksack River between 1984 and 2016, escapement fluctuated between about 103 and 668 fish (1992 and 2016, respectively, WDFW 2020b). Discounting stays from the North Fork, spawning by natural-origin fish in the South Fork Nooksack River has fluctuated between 10 and 323 fish since origin counts began in 1999, accounting for about 4 to 48% of the total count for returning adults. Natural-origin strays from the North Fork consistently comprised a significant proportion of the annual counts, often outnumbering South Fork natural-origin spawners. Total abundance was 668 fish in 2016, with

South Fork natural-origin spawners (323 fish) accounting for 48% of the return, 182 fish were natural-origin strays from the North Fork.

In this basin, returning adults tend to enter the river and migrate upstream early-June through early-September. Spawning occurs from early August to late-October. Yearling stream-type fish tend to leave the river late winter through spring, and move relatively directly to nearshore marine areas and pocket estuaries. Out-migrating ocean-type fry tend to migrate out of the river beginning in early-March. Those fish rear in the tidal delta estuaries of their natal stream for about 2 weeks to 2 months before migrating to marine nearshore areas and pocket estuaries in late May to June. Out-migrating young of the year parr tend to move relatively directly into marine nearshore areas and pocket estuaries after leaving their natal streams between late spring and the end of summer.

Puget Sound/Georgia Basin (PS/GB) Bocaccio

The PS/GB bocaccio distinct population segment (DPS) was listed as endangered on April 28, 2010 (75 FR 22276). In April 2016, we completed a 5-year status review that recommended the DPS retain its endangered classification (Tonnes et al. 2016), and we released a recovery plan in October 2017 (NMFS 2017b).

The VSP criteria described by McElhaney et al. (2000), and summarize at the beginning of Section 2.2, identified spatial structure, diversity, abundance, and productivity as criteria to assess the viability of salmonid species because these criteria encompass a species' "reproduction, numbers, or distribution" as described in 50 CFR 402.02. These viability criteria reflect concepts that are well founded in conservation biology and are generally applicable to a wide variety of species because they describe demographic factors that individually and collectively provide strong indicators of extinction risk for a given species (Drake et al. 2010), and are therefore applied here for PS/GB bocaccio.

General Life History: The life history of bocaccio includes a larval/pelagic juvenile stage that is followed by a juvenile stage, and subadult and adult stages. As with other rockfish, bocaccio fertilize their eggs internally and the young are extruded as larvae that are about 4 to 5 mm in length. Females produce from several thousand to over a million offspring per spawning (Love et al. 2002). The timing of larval parturition in PS/GB bocaccio is uncertain, but likely occurs within a five to six month window that is centered near March (Greene and Godersky 2012; NMFS 2017b; Palsson et al. 2009). Larvae are distributed by prevailing currents until they are large enough to actively swim toward preferred habitats, but they can pursue food within short distances immediately after birth (Tagal et al. 2002). Larvae are distributed throughout the water column (Weis 2004), but are also observed under free-floating algae, seagrass, and detached kelp (Love et al. 2002; Shaffer et al. 1995). Unique oceanographic conditions within Puget Sound likely result in most larvae staying within the basin where they are released rather than being broadly dispersed (Drake et al. 2010).

At about 3 to 6 months old and 1.2 to 3.6 inches (3 to 9 cm) long, juvenile bocaccio gravitate to shallow nearshore waters. Rocky or cobble substrates with kelp is most typical, but sandy areas with eelgrass are also utilized for rearing (Carr 1983; Halderson and Richards 1987; Hayden-

Spear 2006 in Heifetz et al. 2007; Love et al. 1991 & 2002; Matthews 1989; NMFS 2017b; Palsson et al. 2009). Young of the year rockfish may spend months or more in shallow nearshore rearing habitats before transitioning toward deeper water habitats (Palsson et al. 2009). As bocaccio grow, their habitat preference shifts toward deeper waters with high relief and complex bathymetry with rock and boulder-cobble complexes (Love et al. 2002), but they also utilize non-rocky substrates such as sand, mud, and other unconsolidated sediments (Miller and Borton 1980; Washington 1977). Adults are most commonly found between 131 to 820 feet (40 to 250 m) (Love et al. 2002; Orr et al. 2000). The maximum age of bocaccio is unknown, but may exceed 50 years, and they reach reproductive maturity near age six.

<u>Spatial Structure and Diversity:</u> The PS/GB bocaccio DPS includes all bocaccio from inland marine waters east of the central Strait of Juan de Fuca and south of the northern Strait of Georgia. The waters of Puget Sound and Straits of Georgia can be divided into five interconnected basins that are largely hydrologically isolated from each other by relatively shallow sills (Burns 1985; Drake et al. 2010). The basins within US waters are: (1) San Juan, (2) Main, (4) South Sound, and (4) Hood Canal. The fifth basin consists of Canadian waters east and north of the San Juan Basin into the Straights of Georgia (Tonnes et al. 2016). Although most individuals of the PS/GB bocaccio DPS are believed to remain within the basin of their origin, including larvae and pelagic juveniles, some movement between basins occurs, and the DPS is currently considered a single population.

<u>Abundance and Productivity:</u> The PS/GB bocaccio DPS exists at very low abundance and observations are relatively rare. No reliable range-wide historical or contemporary population estimates are available for the PS/GB bocaccio DPS. It is believed that prior to contemporary fishery removals, each of the major PS/GB basins likely hosted relatively large, though unevenly distributed, populations of bocaccio. They were likely most common within the South Sound and Main Basin, but were never a predominant segment of the total rockfish abundance within the region (Drake et al. 2010). The best available information indicates that between 1965 and 2007, total rockfish populations have declined by about 70 percent in the Puget Sound region, and that bocaccio have declined by an even greater extent (Drake et al. 2010; Tonnes et al. 2016; NMFS 2017b).

<u>Limiting Factors</u>: Factors limiting recovery for PS/GB bocaccio include:

- Fisheries Removals (commercial and recreational bycatch)
- Derelict fishing gear in nearshore and deep-water environments
- Degraded water quality (chemical contamination, hypoxia, nutrients)
- Climate change
- Habitat disruption

<u>PS/GB Bocaccio within the Action Area:</u> Very little specific information is available to describe PS/GB bocaccio in the action area. The intertidal and shallow subtidal zones within the area of affect for fish consists of shallow low-relief substrate that consists mostly of boulders, cobbles, gravel, and large-grained sand. Patchy macroalgae is present on cobbles and boulders that are deeper than 2 feet above mean lower low water (+2 ft. MLLW). This habitat is suitable for juvenile bocaccio settlement and early growth. No deep-water habitat with steep banks that may support adult bocaccio is present within the area of affect for fish (NOAA 2018; 2020).

Therefore, the bocaccio that may be present at the project site would likely be limited to pelagic larvae that carried in by the currents and young of the year juveniles that may rear in the shallow subtidal macroalgae at the site. Based on bocaccio life history characteristics, larva and/or young of the year juvenile bocaccio could be present at the project site almost year round, but are most likely to be present between March and October. The best available information suggests that bocaccio were never very common near the action area, and they are now considered rare in Puget Sound, including in the areas where they were historically most common, such as the South Sound (Palsson et al. 2009).

Critical Habitat

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

Puget Sound Chinook Salmon Critical Habitat

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

The PBFs of salmonid critical habitat include: (1) Freshwater spawning sites with water quantity and quality conditions and substrate supporting spawning, incubation and larval development; (2) Freshwater rearing sites with: (i) Water quantity and floodplain connectivity to form and maintain physical habitat conditions and support juvenile growth and mobility; (ii) Water quality and forage supporting juvenile development; and (iii) Natural cover such as shade, submerged and overhanging large wood, log jams and beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks; (3) Freshwater migration corridors free of obstruction and excessive predation with water quantity and quality conditions and natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels, and undercut banks supporting juvenile and adult mobility and survival; (4) Estuarine areas free of obstruction and excessive predation with: (i) Water quality, water quantity, and salinity conditions supporting juvenile and adult physiological transitions between fresh- and saltwater; (ii) Natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels; and (iii) Juvenile and adult forage, including aquatic invertebrates and fishes, supporting growth and maturation; (5) Nearshore marine areas free of obstruction and excessive predation with: (i) Water quality and quantity conditions and forage, including aquatic invertebrates and fishes, supporting growth and maturation; and (ii) Natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, and side channels; and (6) Offshore marine areas with water quality conditions and forage, including aquatic invertebrates and fishes, supporting growth and maturation. The PBF for PS Chinook salmon CH are listed in Table 4.

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

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

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

Land use practices have likely accelerated the frequency of landslides delivering sediment to streams. Fine sediment from unpaved roads also contributes to stream sedimentation. Unpaved roads are widespread on forested lands in the Puget Sound basin, and to a lesser extent, in rural residential areas. Historical logging removed most of the riparian trees near stream channels.

Subsequent agricultural and urban conversion permanently altered riparian vegetation in the river valleys, leaving either no trees, or a thin band of trees. The riparian zones along many agricultural areas are now dominated by alder, invasive canary grass and blackberries, and provide substantially reduced stream shade and recruitment of large wood (SSPS 2007).

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

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

Peak stream flows have increased over time due to paving (roads and parking areas), reduced percolation through surface soils on residential and agricultural lands, simplified and extended drainage networks, loss of wetlands, and rain-on-snow events in higher elevation clear cuts (SSPS 2007). In urbanized Puget Sound, there is a strong association between land use and land cover attributes and rates of coho spawner mortality likely due to runoff containing contaminants emitted from motor vehicles (Feist et al. 2011).

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

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

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

Puget Sound/Georgia Basin Bocaccio Critical Habitat

NMFS designated critical habitat for PS/GB bocaccio on November 13, 2014 (79 FR 68042). That critical habitat includes marine waters and substrates of the US in Puget Sound east of Green Point in the Strait of Juan de Fuca. Nearshore critical habitat is defined as areas that are contiguous with the shoreline from the line of extreme high water out to a depth no greater than 98 feet (30 m) relative to mean lower low water. The PBF of nearshore critical habitat include settlement habitats with sand, rock, and/or cobble substrates that also support kelp. Important site attributes 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. Deepwater critical habitat is defined as areas at depths greater than 98 feet (30 m) that possess or are adjacent to complex bathymetry consisting of rock and/or highly rugose habitat. Important site attributes include: (1) Quantity, quality, and availability of prey species to support individual growth, survival, reproduction, and feeding opportunities; (2) Water quality and sufficient levels of DO 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. Both nearshore and deepwater critical habitat include the entire water column above those substrates. Table 5 lists the PBF and corresponding life history events for PS/GB bocaccio critical habitat.

Table 5. Physical or biological features (PBFs) of designated critical habitat for PS/GB bocaccio, and corresponding life history events.

Physical or Biological Features		
Site Type	**Site Attributes**	**Species Life History Event**
Nearshore habitats with substrate that supports kelp	Prey quantity, quality, and availability Water quality and sufficient DO	Juvenile settlement, growth, and development
Deepwater habitats with Complex bathymetry	Prey quantity, quality, and availability Water quality and sufficient DO	Adult growth and reproduction,

Designated critical habitat for PS/GB bocaccio encompasses a total of about 1,083 square miles (1,743 sq. km) of marine habitat in Puget Sound, comprised of about 645 square miles (1,037 sq. km) of nearshore habitat, and about 438 square miles (706 sq. km) of deepwater habitat. Overall, nearshore critical habitat has been degraded in many areas by shoreline development. Both nearshore and deepwater critical habitat has been degraded by the presence of derelict fishing gear and reduced water quality that is widespread throughout Puget Sound.

Over 25 percent of the shoreline within Puget Sound has been impacted by development and armoring (Broadhurst 1998, WDOE 2010a). Shoreline armoring has been linked to reductions in invertebrate abundance and diversity, reduced forage fish reproduction, and reductions in eelgrass and kelp (Dethier et al. 2016; Heerhartz and Toft 2015; Rice 2006; Sobocinski et al. 2010).

Thousands of lost fishing nets and shrimp and crab pots (derelict fishing gear) have been documented within Puget Sound. Most derelict gear is found in waters less than 100 feet deep, but several hundred derelict nets have also been documented in waters deeper than 100 feet (NRC 2014). Derelict fishing gear degrades rocky habitat by altering bottom composition and killing encrusting organisms. It also kills rockfish, salmon, and marine mammals, as well as numerous species of fish and invertebrates that are rockfish prey resources (Good *et al*. 2010).

Over the last century, human activities have impacted the water quality in Puget Sound predominantly though the introduction of a variety of pollutants. Pollutants enter via direct and indirect pathways, including surface runoff; inflow from fresh and salt water, aerial deposition, discharges from wastewater treatment plants, oil spills, and migrating biota. In addition to shoreline activities, fourteen major river basins flow into Puget Sound and deliver contaminants that originated from upland activities such as industry, agriculture, and urbanization. Pollutants include oil and grease, heavy metals such as zinc, copper, and lead, organometallic compounds, chlorinated hydrocarbons, phenols, polychlorinated biphenyls (PCBs), polybrominated diphenyl ethers (PBDEs), and Polycyclic Aromatic Hydrocarbons (PAHs) (COE 2015; WDOE 2010b). Some of these contaminants are considered persistent bioaccumulative toxics (PBTs) that persist in the environment and can accumulate in animal tissues or fat. The Washington State Department of Ecology (WDOE) estimates that Puget Sound receives between 14 and 94 million pounds of toxic pollutants annually (WDOE 2010b).

<u>Critical Habitat within the Action Area:</u> The project site and surrounding area has been designated nearshore marine critical habitat for PS Chinook salmon and PS/GB bocaccio. This critical habitat primarily supports migration of juvenile and adult PS Chinook salmon, and juvenile settlement, growth, and development for P/GB bocaccio (NOAA 2020; WDFW 2020a).

2.3 Action Area

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

The project site is located in marine waters along the eastern shore of the Strait of Georgia, south of Cherry Point, and north of Lummi Bay (Figure 1). As described in Sections 2.5 and 2.12, project-related noise would be the stressor with the greatest range of effects for ESA-listed species under our jurisdiction. All other project-related effects, including indirect effects would be undetectable beyond the range of acoustic effects. The loudest project related sound source would be the proofing of 30-inch diameter steel pipe piles with an impact driver. The maximum theoretical range to where those sounds would be detectable by SR killer whales (the most acoustically sensitive species considered in this consultation) is about 73 miles (117 Km). However, as described in Section 1.12, ambient noise levels make it extremely unlikely that marine mammals would detect project related noise beyond about 15.6 miles (25.12 Km) from the project site. For fish, the maximum range of effects would be about 6,063 feet (1,848 m) around the south breasting dolphin and its walkway. Therefore, the action area for this consultation is defined as the marine waters and substrates within 16 miles of the applicant's pier with no intervening landmass. The action area described above overlaps with the geographic ranges and boundaries of the ESA-listed species and designated critical habitats identified earlier in Table 2. The action area also overlaps with areas that have been designated, under the MSA, as EFH for Pacific Coast salmon, Pacific Coast Groundfish, and Coastal Pelagic Species.

2.4 Environmental Baseline

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

Environmental conditions at the project site and the surrounding area: The applicant's pier is located along the eastern shore of the Strait of Georgia, south of Cherry Point, and north of Lummi Bay (Figure 1). The area is considered estuarine due to the influence of the numerous rivers. The shoreline is routinely exposed to relatively high waves from the west.

The Strait of Georgia is a major coastal waterway for ships delivering to the refineries north and south of the Petrogas Pier, along with the shipping lanes to Canada on the west edge of the Strait of Georgia. The water area immediately west of the pier is designated as the Department of Natural Resources Cherry Point Aquatic Reserve. Landward of the project area, the area is zoned as Heavy Industrial and characterized by local oil refineries (Petrogas 2018; 2020a).

The shoreward end of the applicant's pier is connected to a silo pad that is surrounded by large rock rip rap. The pier extends about 1,490 feet from the shore, and is about 943 feet wide between the widest mooring dolphins at the offshore end. A14-foot wide, solid-decked pier extends about 1,437 feet from the mean higher high water (MHHW) line along the rip rapped shoreline. A 53-foot wide ell extends 426 feet north-northwest from the end of the pier. Walkway-connected mooring dolphins are located off both ends of the ell. The underside of the structure is between about 19 feet above mean lower low water (+19 ft MLLW) and +10 ft MHHW. The water depth under the pier varies from the MHHW line, to about -38 ft MLLW along the offshore end of the pier where ships moor.

Except where rip rap has been installed around the applicant's pier landing, beach sediments along the shore consist of a gravel and sand mix. Between about 2 and 10 feet above mean lower low water (+2 to +10 ft. MLLW), the substrate consists of coarse sand, mixed cobble, and boulders. In the intertidal and shallow subtidal zones to about - 10 ft MLLW, the substrate is dominated by boulders, cobbles, gravel, and large-grained sand. Patchy macroalgae is present on cobbles and boulders below +2 ft MLLW, but no eelgrass is reportedly within 25 feet of the pier (Petrogas 2018; 2020a). The shoreline at, and well north and south of the project site, are identified by the State as documented herring and surf smelt spawning habitat, with the exception that no smelt spawning occurs where the rip rap has been installed (WDFW 2018c).

Adult PS Chinook salmon from the Strait of Georgia MPG are likely to migrate through the action area to reach their spawning habitats. Juveniles from that MPG are likely to shelter and forage in the action area as they migrate and continue to adapt to the marine environment. Larval PS/GB bocaccio could drift though the action area on the currents, and some juveniles may utilize the macroalgae as rearing habitat before moving into deep-water habitats offshore. The action area has also been designated as critical habitat for PS Chinook salmon, PS/GB bocaccio, and SR killer whales.

The past and ongoing anthropogenic impacts described above have impacted these species and critical habitats through reduced quantity and quality of the migratory and rearing habitat, including reduced water quality caused by the introduction of low levels of pollutants related to upland development and vessel operations.

Climate Change: Climate change has affected the environmental baseline of aquatic habitats across the region and within the action area. However, the effects of climate change have not been homogeneous across the region, nor are they likely to be in the future. During the last century, average air temperatures in the Pacific Northwest have increased by 1 to 1.4° F (0.6 to 0.8º C), and up to 2° F (1.1º C) in some seasons (based on average linear increase per decade; Abatzoglou et al. 2014; Kunkel et al. 2013). Recent temperatures in all but two years since 1998 ranked above the 20th century average (Mote et al. 2013). Warming is likely to continue during the next century as average temperatures are projected to increase another 3 to 10° F (1.7 to 5.6º C), with the largest increases predicted to occur in the summer (Mote et al. 2014).

Decreases in summer precipitation of as much as 30% by the end of the century are consistently predicted across climate models (Mote et al. 2014). Precipitation is more likely to occur during October through March, less during summer months, and more winter precipitation will be rain than snow (ISAB 2007; Mote et al. 2013 and 2014). Earlier snowmelt will cause lower stream flows in late spring, summer, and fall, and water temperatures will be warmer (ISAB 2007; Mote et al. 2014). Models consistently predict increases in the frequency of severe winter precipitation events (i.e., 20-year and 50-year events), in the western United States (Dominguez et al. 2012). The largest increases in winter flood frequency and magnitude are predicted in mixed rain-snow watersheds (Mote et al. 2014).

The combined effects of increasing air temperatures and decreasing spring through fall flows are expected to cause increasing stream temperatures; in 2015, this resulted in 3.5-5.3º C increases in Columbia Basin streams and a peak temperature of 26º C in the Willamette (NWFSC 2015). Overall, about one-third of the current cold-water salmonid habitat in the Pacific Northwest is likely to exceed key water temperature thresholds by the end of this century (Mantua et al. 2009). Higher temperatures will reduce the quality of available salmonid habitat for most freshwater life stages (ISAB 2007). Reduced flows will make it more difficult for migrating fish to pass physical and thermal obstructions, limiting their access to available habitat (Isaak et al. 2012; Mantua et al. 2010). Temperature increases shift timing of key life cycle events for salmonids and species forming the base of their aquatic food webs (Crozier et al. 2011; Tillmann and Siemann 2011; Winder and Schindler 2004). Higher stream temperatures will also cause decreases in DO and may also cause earlier onset of stratification and reduced mixing between layers in lakes and reservoirs, which can also result in reduced oxygen (Meyer et al. 1999; Raymondi et al. 2013; Winder and Schindler 2004). Higher temperatures are likely to cause several species to become more susceptible to parasites, disease, and higher predation rates (Crozier et al. 2008; Raymondi et al. 2013; Wainwright and Weitkamp 2013).

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

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

2.5 Effects of the Action

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

As described in Section 1.3, the COE authorized emergency repairs at the applicant's pier that included in- and over-water work that was done December 16, 2019 through April 30, 2020, and

August 13, 2020 through December 4, 2020. The work included tugboat and barge operations, in-water vibratory and impact pile driving, and use of handheld underwater power tools. The project caused direct effects on fish and habitat resources that were present during the in-water work phases thorough exposure to some combination of work-related noise, contaminated water, and propeller wash, and indirect effects through forage contamination.

Juvenile PS Chinook salmon were very likely present during the last 2 months of the December 2019 - April 2020 phase, and the first 2 months of the August - December 2020 phase. Adult PS Chinook salmon were very unlikely to be present during the first phase of work, but they were likely present during the first 2 months of the August - December 2020 phase.

The rarity of PS/GB bocaccio in Puget Sound and the relatively short durations of project-related work support the understanding that it is extremely unlikely that any PS/GB bocaccio were present during either phase of work. However, the expectation that the project's impact on forage contamination would likely last years, the project is likely to cause indirect effects on juvenile PS Chinook salmon and juvenile PS/GB bocaccio through exposure to contaminated forage.

2.5.1 Effects on Listed Species

Work-related Noise

Exposure to work-related noise likely caused adverse effects in juvenile PS Chinook salmon and minor effects in adults. It is extremely unlikely that any PS/GB bocaccio were exposed to work-related noise. Elevated in-water noise at levels capable of causing detectable effects in exposed fish were caused by the in-water use of impact and vibratory pile installation, tugboat operations, barge spud deployments, and wire saw cutting of the concrete cap.

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

The NMFS uses two metrics to estimate the onset of injury for fish exposed to high intensity impulsive sounds (Stadler and Woodbury 2009). The metrics are based on exposure to peak sound level and sound exposure level (SEL), respectively. Both are expressed in decibels (dB). The metrics are: 1) exposure to 206 dB_{peak}; and 2) exposure to 187 dB SEL_{cum} for fish 2 grams or larger, or 183 dB SEL_{cum} for fish under 2 grams. Given the project's location, it is extremely unlikely that any of the exposed juvenile Chinook salmon were under 2 grams. Therefore, the 187 dB cumulative SEL threshold applies for this consultation.

Further, any received level (RL) below 150 dB_{SEL} is considered "Effective Quiet". The distance from a source where the RL drops to 150 dB_{SEL} is considered the maximum distance from that source where fishes can be affected by the noise, regardless of accumulation of the sound energy (Stadler and Woodbury 2009). Therefore, when the range to the 150 dB_{SEL} isopleth exceeds the range to the 187 dB SEL_{CUM} isopleth, the distance to the 150 dB_{SEL} isopleth is the range at which detectable effects would begin, with the 187 dB SEL_{CUM} isopleth identifying the distance within which sound energy accumulation would intensify effects. However, when the range to the 150 dB_{SEL} isopleth is less than the range to the 187 dB SEL_{CUM} isopleth, only the 150 dB_{SEL} isopleth would apply because fish would be extremely unlikely to detect or be affected by the noise outside of the 150 dB_{SEL} isopleth.

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

The estimated in-water source levels (SL, sound level at 1 meter from the source) used in this assessment are based on the best available information, including the acoustic monitoring report for this project (Delphis 2020), recent acoustic assessments for similar projects (NMFS 2016; 2017c; 2018a), and other sources (CalTrans 2015; COE 2011 & 2018; DEA 2011; FHWA 2017).

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

To calculate cumulative SEL (SEL_{CUM}), Stadler and Woodbury (2009), and this assessment use: SEL_{CUM} (dB) = Single strike SEL SL + 10Log(number of pile strikes). The SEL_{CUM} is then applied to the practical spreading loss equation ($RL = SL - 15\log(R)$) to estimate the range to the 187 & 183 dB SEL_{CUM} isopleths. Because the acoustic monitoring report for this action reported all SEL RLs as cumulative SEL for the duration of the event, those equations were applied to the reported SEL_{CUM} to estimate dB SEL_{CUM} SL.

Between April 4 and 15, 2020, the contractors conducted 8 days of mixed vibratory and impact installation of 30-inch steel pipe piles (Tables 1 & 6), with maximums of 13 minutes of vibratory installation and 3,299 pile strikes per day (Delphis 2020). The impact driver was equipped with cushion blocks, and each pile was enclosed by a multi-ringed bubble curtain generator during impact proofing. Acoustic measurements were taken between 32 and 109 meters (m) from the piles. Based on the acoustic monitoring report, and use of the sound attenuation formula identified above, the maximum SLs for impact driving were 211.5 to 226.6 dB_{peak} and 186 to 199 dB_{SEL}. The maximum SLs for vibratory driving were 202 to 221 dB_{peak}, and 176 to 194 dB_{SEL}.

On September 4, 2020, the contractors conducted 1 day of vibratory installation of 12-inch steel pipe piles, with about 25 minutes of vibratory driving required for each pile. No project-specific sound levels were reported. The project also included the in-water use hand-held power tools and a wire concrete saw, as well as episodic noise events from spud deployments and tugboat operations. Based on the best available information and the sound attenuation formula identified above, the maximum SLs for those sources did not exceed 201 dB_{peak} or 174 dB_{SEL} (Table 6).

Table 6. Estimated maximum in-water source levels for project-related work with the estimated ranges to the source-specific effects thresholds for fish.

Source	Acoustic Signature	Source Level	Threshold Range
Impact 30-inch Steel Pipe Piles	< 1.6 kHz Impulsive	227 dB_{peak}	206 dB_{peak} @ 24 m
6 days, with a maximum of 3,299 pile strikes per day.		199 dB_{SEL}	183 dB SEL_{CUM} @ N/A
		199 dB_{SEL}	187 dB SEL_{CUM} @ 1,398 m
		199 dB_{SEL}	150 dB_{SEL} @ 1,848 m
Vibrate 30-inch Steel Pipe Piles	< 2.5 kHz Non-Impulsive	221 dB_{peak}	206 dB_{peak} @ 10 m
8 days, with a maximum of 13 minutes of vibratory noise/day.		194 dB_{SEL}	183 dB SEL_{CUM} @ N/A
		194 dB_{SEL}	187 dB SEL_{CUM} @ 398 m
		194 dB_{SEL}	150 dB_{SEL} @ 858 m
Spuds	< 1,600 Hz Impulsive	201 dB_{peak}	206 dB_{peak} @ N/A
Episodic, when barges are moved. Likely less than 10/day.		168 dB_{SEL}	183 dB SEL_{CUM} @ N/A
		168 dB_{SEL}	187 dB SEL_{CUM} @ N/A
		168 dB_{SEL}	150 @ 16 m
Wire Saw	< 1 kHz Non-Impulsive	189 dB_{peak}	206 dB_{peak} @ N/A
12 days, with estimate 8 hours of cutting per day.		174 dB_{SEL}	183 dB SEL_{CUM} @ N/A
		174 dB_{SEL}	187 dB SEL_{CUM} @ 136 m
		174 dB_{SEL}	150 dB_{SEL} @ 40 m
Vibrate 12-inch Steel Pipe Piles	< 2.5 kHz Non-Impulsive	186 dB_{peak}	206 dB_{peak} @ N/A
2 widely separated 1-day periods, with up to 50 minutes of installation/extraction per day.		170 dB_{SEL}	183 dB SEL_{CUM} @ N/A
		170 dB_{SEL}	187 dB SEL_{CUM} @ 16 m
		170 dB_{SEL}	150 dB_{SEL} @ 22 m
Tugboat Propulsion	< 1,000 Hz Combination	185 dB_{peak}	206 dB_{peak} @ N/A
Estimate 2 hours of vessel noise per day when barges are moved.		170 dB_{SEL}	183 dB SEL_{CUM} @ N/A
		170 dB_{SEL}	187 dB SEL_{CUM} @ N/A
		170 dB_{SEL}	150 dB_{SEL} @ 22 m
Common Pneumatic Tools	Est. < 2 kHz Impulsive	185 dB_{peak}	206 dB_{peak} @ N/A
Estimate 8 hours of tool use per any diver workday.		165 dB_{SEL}	183 dB SEL_{CUM} @ N/A
		165 dB_{SEL}	187 dB SEL_{CUM} @ 29 m
		165 dB_{SEL}	150 @ 10 m

Impact and vibratory pile driving of 30-inch steel pipe piles were the only sources that exceeded the 206 dB_{peak} threshold for the onset of instantaneous injury in fish. During impact proofing of the piles, noise levels above 206 dB_{peak} extended to a maximum of about 79 feet (24 m) around each pile, while sound levels above 150 dB_{SEL} extended to about 6,063 feet (1,848 m). During vibratory driving, noise levels above 206 dB_{peak} extended to a maximum of about 33 feet (10 m) around each pile, and sound levels above 150 dB_{SEL} extended to about 2,815 feet (858 m). The threshold ranges for all other sources were much shorter.

Any fish that were within 79 feet (24 m) of ongoing impact driving or 33 feet (10 m) of ongoing vibratory driving of 30-inch steel pipe piles likely experienced physical injury that included some combination of TTS, PTS, and injury to non-auditory tissues that reduced the probability of their long-term survival, and may have resulted in immediate mortality for some. Any fish that remained within 4,587 feet (1,398 m) of ongoing impact driving or within 1,306 feet (398 m) of ongoing vibratory driving over an entire work day likely accumulated enough sound energy to experience some combination of TTS, PTS, and injury to non-auditory tissues that reduced the probability of long-term survival for some exposed individuals. The intensity of these effects increased with proximity to the source and the duration of exposure.

Any fish that were within the 150 dB_{SEL} isopleths for any of the noise sources likely experienced a range of impacts that depended on their distance from the source and the duration of their exposure. Those at the far limit of the range likely experienced temporary minor behavioral disturbances such as mild acoustic masking, alerting behaviors, and altered swimming patterns. The intensity of effect would increase with proximity to the source and the duration of exposure, such that alerting and altered swimming would likely include avoidance or abandonment of the area around the source, release of stress hormones, and reduced predator avoidance.

During 30-inch steel pile installation, in-water sound levels above 150 dB_{SEL} likely extended up to 6,063 feet (1,848 m) and 2,815 feet (858 m) for impact and vibratory installation, respectively. During the cutting of the concrete cap with the wire saw, in-water sound levels above 150 dB_{SEL} likely extended up to 131 feet (40 m). For all other work, sound levels above 150 dB_{SEL} likely extended between about 33 and 72 feet (10 and 22 m) around the project area. Due to the differences in their frequencies and other sound characteristics, the various sound sources were very unlikely to have had any additive effects with each other. At most, the combination of the various types of equipment during any given day may have caused fish-detectable in-water noise levels across entire workdays.

The timing of 30-inch pile installation supports the understanding that adult Chinook salmon exposure to that noise was extremely unlikely. The relatively small sizes of the affected area for all other sound sources supports the understanding that exposed adult Chinook salmon would at most experience minor behavioral effects such as temporary avoidance of the project area that would cause no detectable fitness effects in the exposed individuals.

Conversely, juvenile Chinook salmon were likely present within the action area during both work phases, including 30-inch pile installation, and those fish were likely still shoreline obligated, which meant that they likely experienced delayed migration past the project area, and/or remained within the ensonified area for extended periods as they migrated past the pier. Therefore, it is extremely likely that some juvenile Chinook salmon were adversely affected by work-related noise. The number of adversely affected juvenile Chinook salmon is unquantifiable with any degree of certainty. However, based on the work area's offshore location and on the relatively short durations of work, the number of exposed individuals likely comprised a very small subset of their population's 2020 cohort. Further, the number of individuals that were measurably affected by the exposure most likely comprised a small subset of the total number of exposed individuals. Therefore, it is extremely unlikely that the number of individuals that were injured or killed by this stressor was high enough to cause any detectable population-level effects.

Work-related Contaminated Water

Work-related contaminated water likely caused only minor effects in PS Chinook salmon. It is extremely unlikely that any PS/GB bocaccio were or would be exposed to work-related contaminated water. Water quality was temporarily affected through increased turbidity. It may also have been temporarily affected by reduce DO concentrations and by toxic materials introduced to the water through work-related spills and discharges.

Turbidity: Removal of the temporary mooring buoy, destroyed piles, and sunken debris, as well as hand dredging of sediments from the concrete dolphin cap and tugboat propeller wash mobilized bottom sediments during the completed phases. Final debris and temporary pile removal and propeller wash would similarly mobilize sediments during the final phase of work. The best available information supports the understanding that project-related turbidity plumes were, and would again be, episodic, localized (less than 300 feet), short-lived, and consisted of relatively low concentrations of total suspended sediments (TSS). The intensity of turbidity is typically measured in Nephlometric Turbidity Units (NTU) that describe the opacity caused by the suspended sediments, or by the concentration of TSS as measured in milligrams per liter (mg/L). A strong positive correlation exists between NTU values and TSS concentrations. Depending on the particle sizes, NTU values roughly equal the same number of mg/L for TSS (i.e. 10 NTU = ~ 10 mg/L TSS, and 1,000 NTU = ~ 1,000 mg/L TSS) (Campbell Scientific Inc. 2008; Ellison et al. 2010). Therefore, the two units of measure are easily compared.

Water quality is considered adversely affected by suspended sediments when turbidity is increased by 20 NTU for a period of 4 hours or more (Berg and Northcote 1985; Robertson et al. 2006). The effects of turbidity on fish are somewhat species and size dependent. In general, severity typically increases with sediment concentration and duration of exposure, and decreases with the increasing size of the fish. Bjornn and Reiser (1991) report that adult and larger juvenile salmonids appear to be little affected by the high concentrations of suspended sediments that may be mobilized during storm and snowmelt runoff episodes. However, empirical data from numerous studies report the onset of minor physiological stress in juvenile and adult salmon after one hour of continuous exposure to suspended sediment concentration levels between about 1,100 and 3,000 mg/L, or to three hours of exposure to 400 mg/L, and seven hours of exposure to concentration levels as low as 55 mg/L (Newcombe and Jensen 1996). The authors reported that serious non-lethal effects such as major physiological stress and reduced growth were reported after seven hours of continuous exposure to 400 mg/L and 24 hours of continuous exposures to concentration levels as low as about 150 mg/L.

Vibratory removal of hollow 30-inch steel piles in Lake Washington mobilized sediments that adhered to the piles as they were pulled up through the water column (Bloch 2010). Turbidity reached a peak of about 25 NTU (~25 mg/L) above background levels at 50 feet from the pile, and about 5 NTU (~5 mg/L) above background at 100 feet. Turbidity returned to background levels within 30 to 40 minutes. Pile installation created much lower turbidity.

The amount of bottom sediments that were mobilized during the lifting of the three 400-foot long anchor chains and six 6,000-pound anchors for the temporary mooring buoy was not described by the COE. Conservatively assuming that the anchor flukes would lift four times as much sediment as a 30-inch dimeter pipe pile, the resulting turbidity may have been up to 100 NTU (~100 mg/L) above background levels 50 feet away, and 20 NTU (~20 mg/L) above background levels at 100 feet, with turbidity returning to background levels within a low number of hours after work stopped.

It is extremely unlikely that the removal of timber piles and other debris related to the failed dolphin and walkway, or the 2 temporary piles mobilized sediments beyond that reported by Bloch, because the timber and temporary piles have much smaller surface areas for sediments to adhere to, and the other debris was not deeply embedded. Lifting barge spuds would also mobilize sediments, but likely less than that of pile removal because the spuds would not be embedded as deeply as the piles described above. The applicant reported that the turbidity plumes from hand dredging around the dolphin cap were always under 300 feet.

Tugboat propeller wash also mobilized bottom sediments. The exact intensity and duration of the resulting turbidity plumes were unreported other than the applicant's assertion that no turbidity plumes exceeded 300 feet. A recent study described the turbidly caused by large tugboats operating in Navy harbors (ESTCP 2016). At about 13 minutes, the plume extended about 550 yards (500 m) and had a TSS concentration of about 80 mg/L. The plume persisted for hours and extended far from the event, but the TSS concentration fell to 30 mg/L within 1 hour and to 15 mg/L within 3 hours. At its highest concentration, the plume was below the concentrations required to elicit physiological responses reported by Newcombe and Jensen (1996). Because the project-related tugboat turbidity was less than that considered above, its intensity and duration were too low to cause meaningful effects on the normal behavior or fitness of exposed fish.

Based on the best available information, work-related turbidity concentrations were too low and short-lived to cause more than temporary, non-injurious behavioral effects such as avoidance of the plumes and mild gill flaring (coughing) in any PS Chinook salmon that may have been exposed. None of these potential responses, individually, or in combination would affect the fitness or meaningfully affect normal behaviors in exposed fish.

<u>Dissolved Oxygen:</u> Mobilization of anaerobic sediments can decrease dissolved oxygen levels (Hicks et al., 1991; Morton 1976). The impact on dissolved oxygen is a function of the oxygen demand of the sediments, the amount of material suspended in the water, the duration of suspension, and the water temperature (Lunz and LaSalle 1986; Lunz et al. 1988). Reduced dissolved oxygen can affect salmonid swimming performance (Bjornn and Reiser 1991), as well as cause avoidance of water with low dissolved oxygen levels (Hicks 1999). However, the small amount of sediments that were mobilized combined with the high level of water mixing due to tidal and wind currents supports our understanding that any dissolved oxygen reductions were too small and short-lived to cause detectable effects in exposed fish.

Toxic Materials: Toxic materials may have entered the water through work-related spills and discharges, the mobilization of contaminated sediments, and/or the release of PAHs from creosote-treated timber piles during their removal. Fish can uptake contaminants directly through their gills, and through dietary exposure (Karrow et al. 1999; Lee and Dobbs 1972; McCain et al. 1990; Meador et al. 2006; Neff 1982; Varanasi et al. 1993). Many of the fuels, lubricants, and other fluids commonly used in motorized vehicles and construction equipment are petroleum-based hydrocarbons that contain PAHs, which are known to be injurious to fish. Other contaminants can include metals, pesticides, PCBs, phlalates, and other organic compounds. Depending on the pollutant, its concentration, and/or the duration of exposure, exposed fish may experience effects that can range from avoidance of an affected area, to reduced growth, altered immune function, and mortality (Beitinger and Freeman 1983; Brette et al. 2014; Feist et al. 2011; Gobel et al. 2007; Incardona et al. 2004, 2005, and 2006; Mcintyre et al. 2012; Meadore et al. 2006; Sandahl et al. 2007; Spromberg et al. 2015).

The project included best management practices (BMPs) intended to reduce the risk and intensity of discharges and spills, and no spills were reported. If any work-related spills or discharges did occur, it is extremely likely that they were very small, and quickly contained and cleaned. Based on the best available information, any in-water presence of project-related contaminants was very infrequent, short-lived, and at concentrations too low to cause detectable effects in exposed fish.

The sediments that were mobilized during the various work components very likely contained PAHs from the creosote-treated piles, and may have also contained other contaminants such as other petroleum-based hydrocarbons and metals. PAHs may have also been released directly from any timber piles that broke during their removal (Evans et al. 2009; Parametrix 2011; Smith 2008; Werme et al. 2010). As described above, the amount of sediment that was mobilized by the project was relatively small. Further, most of the volatile contaminants that were mobilized, such as lighter PAHs likely dissipated within a few hours, through evaporation at the surface and/or dilution in the water column (Smith 2008; Werme et al. 2010). Most of the remaining contaminants likely settled out of the water along with the sediments. Therefore, in-water contaminant concentrations from sediment mobilization were likely very low and short-lived. The NMFS estimates that all detectable water quality impacts were limited to the extent of the project-related visible turbidity plumes, which reportedly never exceeded 300 feet from the activity. In the unlikely event of fish exposure to waterborne contaminants, the in-water concentrations and durations were likely too low to cause anything more than mild avoidance of the affected area.

Removal of the 45 creosote-treated piles that sunk with the dolphin and walkway would slightly reduce the number of similar piles that are sources of ongoing PAH contamination from the pier. Their removal is likely to cause some minor long-term improvement of water quality within the action area. However, the amount of improvement and the exact effects it may have on salmonids and their habitat resources within the action area is uncertain, particularly given the large number of creosote-treated piles and other sources of contamination that would remain in the area after the project is complete.

Based on the best available information, as described above, any fish that may be exposed to work-related water contamination would experience no more than temporary low-level behavioral effects, which individually, or in combination would not affect the fitness of exposed individuals.

Work-related Propeller Wash

Work-related propeller wash likely caused adverse effects in juvenile PS Chinook salmon and minor effects in adults. It is extremely unlikely that any PS/GB bocaccio were exposed to work-related propeller wash. Spinning boat propellers kill fish and small aquatic organisms (Killgore et al. 2011; VIMS 2011). Spinning propellers also generate fast-moving turbulent water that is known as propeller wash. Exposure to propeller wash can displace and disorient small fish. It can also mobilize sediments and dislodge aquatic organisms and submerged aquatic vegetation (SAV), particularly in shallow water and/or at high power settings. This is called propeller scour.

Project-related tugboat operations caused propeller wash within the action area while juvenile and adult Chinook salmon were present within the action area. Adult Chinook salmon likely avoided construction-related noise and activity. Further, they were very able to swim against most work-related propeller wash they may have been exposed to without any meaningful effect on their fitness or normal behaviors. Conversely, juvenile Chinook salmon that were present were likely relatively close to the surface and too small to effectively swim against the propeller wash. Individuals that were struck or very nearly missed by a spinning propeller were injured or killed by the exposure. Some of the fish that were farther away were likely displaced by the turbulent water. Depending on the direction and strength of the thrust plume, the displacement likely increased energetic costs and reduced feeding success for some individuals, and may have increased the vulnerability to predators for individuals that were stunned and/or disoriented by the wash.

The number of juvenile PS Chinook salmon that were adversely affected by work-related propeller wash is unquantifiable with any degree of certainty. However, because the juvenile PS Chinook salmon that were present during this project's work phases would have been largely shoreline oriented, it is most likely that extremely few individuals from the 2020 cohort were near the work area, which was about 1,490 feet from the shore. Based on the work area's offshore location, and on the short duration and episodic timing of tugboat operations, the total number of individuals that were exposed to project-related propeller wash likely comprised an extremely small subset of their cohort. Further, the number of individuals that were measurably affected by the exposure most likely comprised a small subset of the total number of exposed individuals. Therefore, the total number of individuals that were injured or killed by this stressor was too low to cause any detectable population-level effects.

The water depth where work-related tugboats operated (-35 ft MLLW and deeper), suggests that propeller scour had very little impact on the density and diversity of the benthic community and SAV at the project site. Further, the affected area comprised a tiny portion of the similar substrate in the immediate area, and the disturbed benthic communities are likely to recover very quickly. Therefore, the effects of propeller scour were too small to cause any detectable effects on the fitness and normal behaviors of juvenile Chinook salmon and PS/GB bocaccio in the action area.

Work-related Contaminated Forage

Exposure to contaminated forage is likely to adversely affect juvenile PS Chinook salmon and juvenile PS/GB bocaccio, but is unlikely to cause detectable effects in adults of either species. In addition to direct uptake of contaminants through their gills, fish can absorb contaminants through dietary exposure (Meador et al. 2006; Varanasi et al. 1993). Relatively small amounts of contaminated subsurface sediments mobilized into the water column by the removal of debris, buoy anchors, temporary piles, and by hand dredging around the dolphin cap. Those sediments soon settled onto the top layer of the substrate, where contaminants such as PAHs, other petroleum-based hydrocarbons, and heavy metals may remain biologically available for years.

Romberg (2005) discusses the spread of contaminated sediments that were mobilized by the removal of creosote-treated piles from the Seattle Ferry Terminal, including digging into the sediment with a clamshell bucket to remove broken piles. Soon after the work, high PAH levels were detected 250 to 800 feet away, across the surface of a clean sand cap that had been installed less than a year earlier. Concentrations decreased with distance from the pile removal site, and with time. However, PAH concentrations remained above pre-contamination levels 10 years later. Lead and mercury values also increased on the cap, but the concentrations of both metals decreased to background levels after 3 years.

Amphipods and copepods uptake PAHs from contaminated sediments (Landrum and Scavia 1983; Landrum et al. 1984; Neff 1982), and pass them to juvenile Chinook salmon and other small fish through the food web. Varanasi et al. (1993) found high levels of PAHs in the stomach contents of juvenile Chinook salmon in a contaminated waterway (Duwamish). They also reported reduced growth, suppressed immune competence, as well as increased mortality in juvenile Chinook salmon that was likely caused by the dietary exposure to PAHs. Meador et al. (2006) demonstrated that dietary exposure to PAHs caused “toxicant-induced starvation” with reduced growth and reduced lipid stores in juvenile Chinook salmon. The authors surmised that these impacts could severely impact the odds of survival in affected juvenile Chinook salmon.

The project’s sediment mobilization was far less severe than was described by Romberg (2005). However, the sediments that were mobilized were almost certainly contaminated by PAHs, other hydrocarbons, and heavy metals. Most of the sediment, and therefore the highest concentrations of contaminants, likely settled out of the water close to the point of mobilization. However, currents and tugboat propeller likely spread some of the contaminated sediments as far away as 300 feet. Within that distance, mobilized contaminants would remain biologically available for years, but at ever decreasing concentration levels.

The number of years that detectable amounts of contaminants would be biologically available, as well as the annual number of juvenile PS Chinook salmon and juvenile PS/GB bocaccio that may be exposed to contaminated forage that would be attributable to this action is unquantifiable with any degree of certainty. Similarly, the amount of contaminated prey that any individual fish may consume, or the intensity of any effects that an exposed individual may experience is uncertain, and would be highly variable over time. However, the relatively small affected area and its distance from preferred nearshore marine habitat for juvenile Chinook salmon suggest that the probability of trophic connectivity to the contamination would be very low for any individual fish. Similarly, the combination of the small size of the affected area and the rarity of juvenile bocaccio in the action area suggest that extremely few individuals would be exposed to action-related contaminated forage. Therefore, the numbers of juvenile Chinook salmon and juvenile bocaccio that may be annually exposed to action-related contaminated prey would likely comprise such extremely small subsets of their respective cohorts that their loss would cause no detectable population-level effects.

2.5.2 Effects on Critical Habitat

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

It is extremely likely that the proposed action, including full application of its conservation measures and BMPs, adversely affected designated critical habitat for PS Chinook salmon and for PS/GB bocaccio as described below.

Critical Habitat for Puget Sound Chinook Salmon: The proposed action likely caused impacts on the estuarine and nearshore marine areas free of obstruction and excessive predation PBFs of PS Chinook salmon critical habitat as described below. Benthic habitat and waters deeper than 98 feet (30 m) are outside of the range of the proposed action's expected effects on fish. Therefore, it is highly unlikely that the action would cause any impacts on the off shore marine areas PBF.

1. Freshwater spawning sites – None in the action area.

2. Freshwater rearing sites – None in the action area.

3. Freshwater migration corridors free of obstruction and excessive predation – None in the action area.

4. Estuarine areas free of obstruction and excessive predation
   a. Obstruction and predation – The proposed action caused short-term minor adverse effects on this attribute. The project caused no change in the abundance of predators, but work-related noise caused short-term conditions that increased the vulnerability to predators for some juvenile Chinook salmon within about 6,063 feet.
   b. Water quality – The proposed action caused short-term minor adverse effects and long-term minor beneficial effects on this attribute. The action caused no measurable changes in water temperature, but project work caused brief increases in suspended solids and low levels of work-related contaminants. Conversely, the removal of 45 creosote-treated timber piles would slightly reduce ongoing PAH contamination at the pier. Detectable

water quality impacts would be limited to within 300 feet of the southwest end of the pier, with construction-related impacts lasting a low number of hours after work stops.

c. Water quantity – The proposed action caused no effect on this attribute.
d. Salinity – The proposed action caused no effect on this attribute.
e. Natural Cover – The proposed action caused no effect on this attribute.
f. Forage – The proposed action caused long term minor adverse effects on this attribute. Project-related work mobilized relatively small amounts of PAH-contaminated sediments that could contaminate benthic invertebrates that are forage resources for juvenile Chinook salmon. Sediment distribution was limited to the area within 300 feet around the southwest end of the pier, with detectable levels of contaminants expected to decrease over several years.

5. Nearshore marine areas free of obstruction and excessive predation
   a. Obstruction and predation – Same as above.
   b. Water quality – Same as above.
   c. Water quantity – Same as above.
   d. Forage – Same as above.
   e. Natural Cover – Same as above.

6. Offshore marine areas – Outside of the expected range of effects for fish.

PS/GB Bocaccio Critical Habitat: The proposed action likely caused impacts on the nearshore juvenile settlement habitats PBF of PS/GB bocaccio critical habitat as described below. Benthic habitat and waters deeper than 98 feet (30 m) are outside of the range of the proposed action's expected effects on fish. Therefore, it is extremely unlikely that the action would cause any impacts on the deep-water benthic habitat PBF.

1. Juvenile settlement habitats located in the nearshore (shoreline to 98 feet (30 m) deep) with substrates such as sand, rock, and/or cobble compositions that support kelp
   a. Quantity, quality, and availability of prey species – The proposed action caused long-term minor effects on this attribute. Pile and debris removal mobilized relatively small amounts of PAH-contaminated sediments that could contaminate benthic invertebrates that are forage resources for juvenile bocaccio. Sediment distribution was limited to the area within 300 feet around the southwest end of the pier, with detectable levels of contaminants expected to decrease over several years.
   b. Water quality – The proposed action caused short-term minor adverse effects and long-term minor beneficial effects on this attribute. The action caused no measurable changes in water temperature or salinity, but caused brief increases in suspended solids and low levels of work-related contaminants. Conversely, the removal of 45 creosote-treated timber piles would slightly reduce ongoing PAH contamination at the pier. Detectable water quality impacts would be limited to within 300 feet of the southwest end of the pier, with construction-related impacts lasting a low number of hours after work stops.

2. Benthic habitats and sites deeper than 98 feet (30 m) – Outside of the expected range of effects for fish.

2.6 Cumulative Effects

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

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

The current condition of ESA-listed species and designated critical habitat within the action area are described in the status of the species and critical habitat and the environmental baseline sections above. The non-federal activities that have contributed to those conditions include past and on-going shoreline development in the action area, as well as upland agriculture, urbanization, and road construction. Those actions were, and continue to be driven by a combination of economic conditions that characterized traditional natural resource-based industries, general resource demands associated with settlement of local and regional population centers, and the efforts of conservation groups dedicated to restoration and use of natural amenities, such as cultural inspiration and recreational experiences.

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

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

2.7 Integration and Synthesis

The Integration and Synthesis section is the final step in our assessment of the risk posed to species and critical habitat as a result of implementing the proposed action. In this section, we add the effects of the action (Section 2.5) to the environmental baseline (Section 2.4) and the cumulative effects (Section 2.6), taking into account the status of the species and critical habitat (Section 2.2), to formulate the agency's biological opinion as to whether the proposed action is likely to: (1) appreciably reduce the likelihood of both the survival and recovery of a listed species in the wild by reducing its numbers, reproduction, or distribution; or (2) appreciably diminish the value of designated or proposed critical habitat as a whole for the conservation of the species.

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

Climate change may also impact coastal waters through elevated surface water temperature, increased and variable acidity, increasing storm frequency and magnitude, and rising sea levels. The adaptive ability of listed-species is uncertain, but is likely reduced due to reductions in population size, habitat quantity and diversity, and loss of behavioral and genetic variation. The proposed action will cause direct and indirect effects on the ESA-listed species and critical habitats considered in the Opinion well into the foreseeable future. However, the action's effects on water quality, substrates, and the biological environment are expected to be of such a small scale that no detectable effects on ESA-listed species or critical habitat through synergistic interactions with the impacts of climate change are expected.

2.7.1 ESA-listed Species

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

PS Chinook salmon

The long-term abundance trend of the PS Chinook salmon ESU is slightly negative. Reduced or eliminated accessibility to historically important habitat, combined with degraded conditions in available habitat due to land use activities appear to be the greatest threats to the recovery of PS Chinook salmon. Commercial and recreational fisheries also continue to impact this species.

The PS Chinook salmon most likely to occur in the action area would be spring, summer, and fall-run fish from the Nooksack River basin, and spring- and fall-run fish from the Nooksack River basin. The extinction risk for two affected MPGs is considered high due to low abundance and productivity (NWFSC 2015).

The project site is located in the nearshore marine waters of Puget Sound, along the eastern shore of the Strait of Georgia, south of Cherry Point, and north of Lummi Bay. The environmental baseline within the action area has been degraded by more than 100 years of development, maritime activity, upland urbanization, and road building and maintenance. However, adult and juvenile PS Chinook salmon continue to utilize the action area primarily for adult and juvenile migration, and juvenile growth in marine waters.

Very low numbers of out-migrating juveniles were exposed to short term work-related impacts, and very low numbers of out-migrating juveniles would be exposed annually to low levels of contaminated forage for several years after project completion. Project related impacts caused and would continue a range of effects that both individually and collectively alter behaviors, reduce fitness, and possibly cause mortality of low numbers of exposed juveniles for years to come. However, the annual numbers of individuals that are likely to be impacted by action-related stressors is expected to be extremely low.

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

PS/GB bocaccio

No reliable population estimates are available for PS/GB bocaccio. The best available information indicates that they were never a predominant segment of the total rockfish abundance in Puget Sound, and that abundance has declined by more than 70 percent since 1965. They are considered rare in the action area, and it is uncertain whether they currently utilize the habitat within the action area. Fishing removals and derelict fishing gear, combined with degraded water quality appear to be the greatest threats to the recovery of the DPS.

The project site is located in the nearshore marine waters of Puget Sound, along the eastern shore of the Strait of Georgia, south of Cherry Point, and north of Lummi Bay. The environmental baseline within the action area has been degraded by more than 100 years of development, maritime activity, upland urbanization, and road building and maintenance. However, the action area continues to provide habitat features that are considered supportive of juvenile rearing.

Based on the rarity of bocaccio in the action area, and the short duration of the planned work, it is extremely unlikely that any bocaccio were directly exposed to work-related stressors. However, over time, very low numbers of individuals may be exposed to ever-decreasing levels of contaminated forage. Exposure to contaminated forage is likely to cause some combination of altered behaviors, reduced fitness, and mortality in some exposed individuals. However, the annual numbers of individuals that are likely to be impacted by this stressor is expected to be extremely low.

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

2.7.2 Critical Habitat

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

PS Chinook salmon critical habitat

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

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

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

The PBFs for PS salmonid critical habitat in the action area are limited to estuarine and nearshore marine areas that are free of obstruction and excessive predation. The site attributes of those PBFs that were affected by the action are limited to obstruction and predation, water quality, and forage. As described above, the proposed action caused short term minor adverse effects on predation and water quality, as well as long term minor beneficial effects on water quality and long term minor adverse effects on forage. The adverse effects on predation were limited to the area within about 6,063 feet of the project site. The effects on water quality and forage were limited to the area within about 300 feet.

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

PS/GB bocaccio critical habitat

Nearshore rockfish critical habitat has been degraded by past and ongoing shoreline development that has altered shoreline substrates, and reduced eelgrass and kelp habitats in many areas of Puget Sound. Agriculture, industry, urbanization, and maritime activities have reduced water quality throughout Puget Sound, and the widespread presence of derelict fishing gear in both nearshore and deep-water critical habitat areas has altered bottom composition, reduces prey availability, and directly kills rockfish.

Rising sea levels, caused by climate change, are expected to increase coastal erosion and alter the composition of nearshore critical habitat for PS/GB bocaccio. Elevated sea surface temperatures and increased ocean acidification may also reduce the quality of nearshore marine habitats, and reduce prey availability by reducing ocean productivity.

Future non-federal actions and climate change are likely to increase and continue acting against the quality of PS/GB bocaccio critical habitat. The intensity of those influences is uncertain, as is the degree to which those impacts may be tempered by adoption of more environmentally acceptable practices, by restoration activities such as efforts to remove derelict fishing gear, and by efforts to address the effects of climate change.

The PBF for PS/GB bocaccio critical habitat in the action area is limited to nearshore settlement habitats with sand, rock, and/or cobble substrates that also support kelp. The site attributes of that PBF that were and would be affected by the action are limited to prey quantity, quality, and availability, and water quality. As described above, the proposed action caused long term minor adverse effects on forage quality, short term minor adverse effects on water quality, as well as long term minor beneficial effects on water quality. The effects on forage and water quality would be limited to the area within about 300 feet.

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

2.8 Conclusion

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

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 incidental take statement (ITS).

2.9.1 Amount or Extent of Take

In the Opinion, the NMFS determined that incidental take is reasonably certain to have occurred and would continue to occur as follows:

Harm of juvenile PS Chinook salmon from exposure to:

- work-related noise,
- work-related propeller wash, and
- contaminated forage.

Harm of juvenile PS/GB bocaccio from exposure to:

- contaminated forage.

The NMFS cannot predict with meaningful accuracy the number of PS Chinook salmon and PS/GB bocaccio that are reasonably certain to be injured or killed by exposure to the stressors identified above. The distribution and abundance of the fish that occur within an action area are affected by habitat quality, competition, predation, and the interaction of processes that influence genetic, population, and environmental characteristics. These biotic and environmental processes interact in ways that may be random or directional, and may operate across far broader temporal and spatial scales than are affected by the proposed action. Thus, the distribution and abundance of fish within the action area cannot be attributed entirely to habitat conditions, nor can the NMFS precisely predict the number of fish that are reasonably certain to be injured or killed if their habitat is modified or degraded by the proposed action. Additionally, the NMFS knows of no device or practicable technique that would yield reliable counts of individuals that may experience action-related impacts.

In such circumstances, the NMFS uses the causal link established between the activity and the likely extent and duration of changes in habitat conditions to describe the extent of take as a numerical level of habitat disturbance. The most appropriate surrogates for take are action-related parameters that are directly related to the magnitude of the expected take.

For this action, the timing and duration of work, the type and size of the piles that were installed/removed, and the method of their installation/removal are the best available surrogates for the extent of take of juvenile PS Chinook salmon from exposure to work-related noise. The timing and duration of work is also the best available surrogate for the extent of take of juvenile PS Chinook salmon from exposure to work-related propeller wash. The methods of anchor, debris, pile, and sediment removal, and the lateral extent of the visible turbidity plumes are the best available surrogates for the extent of take of juvenile PS Chinook salmon and juvenile PS/GB bocaccio from exposure to contaminated forage.

The timing of in-water work is applicable for work-related noise because working between May 1 and August 13 would have caused work-related noise to be present over the center of the peak season for juvenile Chinook salmon within the action area, which would have increased the number of exposed individuals. The duration of in-water work is also applicable because working longer than was done for either work phase would have also exposed more individuals to work-related noise.

The piles and their installation method are applicable for work-related noise because the intensity of effect and the size of the affected area are both positively correlated with the loudness of the sound, which is determined by the type and size of the pile and the method of installation. Further, the number of exposed fish is positively correlated with the size of the ensonified area, especially as the ensonified area extends into shoreline areas where juvenile density is expected to be highest. Therefore, as sound levels increase, the number of exposed individuals increases and the intensity of effects experienced by exposed individuals also increases. Based on the best available information about the pile installation that was performed, as described in Section 2.5, the applicable ranges of effect for impact driving were directly correlated with the type and size of the piles and the number of pile strikes. The applicable ranges of effect for vibratory pile work were also directly correlated with type and size of the piles, but not by the daily duration of vibratory work. Therefore, the daily duration of vibratory pile work is not considered a measure of take for this action.

The timing of in-water work is applicable for work-related propeller wash because working between May 1 and August 13 would have caused propeller wash to be present over the center of the peak season for juvenile Chinook salmon within the action area, which would have increased the number of exposed individuals. The duration of in-water work is also applicable because working longer would have probably increased the number of tugboat trips, which would have also increased the number exposed individuals.

The method of anchor, debris, pile, and sediment removal, and the extent of the visible turbidity plumes around that work are the best available surrogates for the extent of take of juvenile PS Chinook salmon and juvenile PS/GB bocaccio from exposure to contaminated forage. This is because the intensity of surface sediment contamination would be positively correlated with the amount of contaminated subsurface sediments that would be brought to the surface, and the numbers of contaminated prey organisms and/or exposed fish would be positively correlated with the size of the affected area. The use of excavators or water-jetting would likely have mobilized more contaminated sediments than the diver-assisted crane-lifting that was used. As the amount of mobilized contaminated sediments increase, the amount of biologically available contaminants would increase. Also, as the size of the visible turbidity plume increases, the size of the area where contaminated sediments would be biologically available would increase. Therefore, any increase in the amount of mobilized would increase the intensity of contamination, and any increase in the size of the visible turbidity plumes would increase the number of contaminated prey organisms as well as the number of exposed listed fish, both of which would increase the intensity of the exposure and/or the number of exposed juvenile PS Chinook salmon and juvenile PS/GB bocaccio.

In summary:

The extent of PS Chinook salmon take for this action is defined as:
- In-water work, as described in the Federal Action section of this biological opinion, that was completed between December 16, 2019 and April 30, 2020 and between August 13 and December 4, 2020;
- Eight days of vibratory and impact installation of 9 30-inch diameter steel pipe piles between April 4 and 15, 2020 as described in the Federal Action section of this biological opinion;
- One day of vibratory pile installation of 2 12-inch diameter steel pipe piles on September 4, 2020 as described in the Federal Action section of this biological opinion;
- 12 days of underwater wire saw cutting of the concrete dolphin cap between September 4 and October 23, 2020 as described in the Federal Action section of this biological opinion;
- Removal of the temporary mooring buoy’s anchors, all sunken debris, sediment from the concrete dolphin cap, and extraction of 2 12-inch diameter steel pipe piles as described in the Federal Action section of this biological opinion; and
- Visible turbidity plumes extending up to 300 feet from the project area.

The extent of PS/GB bocaccio take for this action is defined as:

- Removal of the temporary mooring buoy's anchors, all sunken debris, sediment from the concrete dolphin cap, and extraction of 2 12-inch diameter steel pipe piles as described in the Federal Action section of this biological opinion; and
- Visible turbidity plumes extending up to 300 feet from the project area.

Any additional work done under the COE's January 16, 2020 emergency authorization for the repair of the south breasting dolphin and catwalk at the Petrogas Pacific LLC pier in Whatcom County, Washington (NWS-2019-1054) would be beyond the exposure limits described above, and would constitute an exceedance of exempted take that would trigger the need to reinitiate consultation.

Although these take surrogates could be construed as partially coextensive with the proposed action, they nevertheless function as effective reinitiation triggers. If the timing and duration and/or the methodology for the removal of the dolphin cap and/or temporary work platform fail to comply with the take surrogates, it could still meaningfully trigger reinitiation because the Corps has authority to conduct compliance inspections and to take actions to address non-compliance, including post-construction (33 CFR 326.4).

2.9.2 Effect of the Take

In the Opinion, the NMFS determined that the amount or extent of anticipated take, coupled with other effects of the proposed action, is not likely to result in jeopardy to PS Chinook salmon and/or PS/GB bocaccio, or destruction or adverse modification of their critical habitats.

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).

Because this consultation considered the effects of action-related work has already been completed, and because project monitoring and post-construction reporting have also been completed, no additional actions can be taken by the COE and/or the applicant to reduce work-related effects, and the monitoring and reporting requirement to ensure that exempted take was not exceeded has been rendered mute. Therefore, this opinion includes no RPMs.

2.9.4 Terms and Conditions

The terms and conditions described below are non-discretionary, and the COE or any applicant must comply with them in order to implement the RPMs (50 CFR 402.14). The COE 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.

Because this opinion includes no RPMs, no terms or conditions to implement the RPMs are required. Therefore, this opinion includes no terms and conditions.

2.10 Conservation Recommendations

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

1. The COE should encourage the applicant to cap exposed contaminated sediments with clean fill material that is appropriate for the project site.

2.11 Reinitiation of Consultation

This concludes formal consultation for the U.S Army Corps of Engineers' emergency authorization of the Emergency Repair of the Petrogas Pacific LLC Pier South Breasting Dolphin and Catwalk, Whatcom County, Washington (NWS-2019-1054). As 50 CFR 402.16 states, reinitiation of consultation is required and shall be requested by the Federal agency or by the Service where discretionary Federal agency involvement or control over the action has been retained or is authorized by law and if: (1) The amount or extent of incidental taking specified in the ITS is exceeded, (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion, (3) the identified action is subsequently modified in a manner that causes an effect to the listed species or critical habitat that was not considered in the biological opinion, or (4) a new species is listed or critical habitat designated that may be affected by the action.

2.12 "Not Likely to Adversely Affect" Determinations

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

As described in Section 2, the COE determined the proposed action is not likely to adversely affect PS steelhead, PS/GB yelloweye rockfish and their designated critical habitat, and SR killer whales and their designated critical habitat. Impacts on critical habitat for PS steelhead was not considered in this opinion because critical habitat for that species doesn't occur within the action area. Detailed information about the biology, habitat, and conservation status and trends of these listed resources can be found in the listing regulations and critical habitat designations published in the Federal Register, as well as in the recovery plans and other sources at: https://www.fisheries.noaa.gov/species-directory/threatened-endangered, and is incorporated here by reference.

The applicable standard to find that a proposed action is not likely to adversely affect listed species or critical habitat is that all of the effects of the action are expected to be discountable, insignificant, or completely beneficial. Beneficial effects are contemporaneous positive effects without any adverse effects to the species or critical habitat. Insignificant effects relate to the size of the impact and should never reach the scale where take occurs. Discountable effects are those extremely unlikely to occur. The effects analysis in this section relies heavily on the descriptions of the proposed action and project site conditions discussed in Sections 1.3 and 2.4, and on effects analyses presented in Section 2.5.

2.12.1 Effects on Listed Species

As described in the analysis of the action's effects (Section 2.5), project-related stressors from the work that has been completed caused no measurable effects on fish beyond about 6,063 feet (1,848 m) from the project site, and the removal of the remaining debris would cause no effects beyond about 300 feet.

Juvenile steelhead are generally independent of shallow nearshore areas soon after entering marine water (Bax et al. 1978, Brennan et al. 2004, Schreiner et al. 1977), and are not commonly caught in beach seine surveys. Recent acoustic tagging studies (Moore et al. 2010) have shown that smolts migrate from rivers to the Strait of Juan de Fuca within one to three weeks. Returning adults typically migrate in relatively deepwater well away from shore until they near the entrance of their natal streams. Based on the best available information concerning PS steelhead distribution, habitat availability, and life history characteristics combined with the relatively small area of effect and the short duration of the in-water work phases, it is extremely unlikely that any individuals of this species were or would be within the action area close enough and/or long enough to be measurably affected by the proposed action. Therefore, the proposed action is not likely to adversely affect PS steelhead.

The best available information concerning the distribution, habitat availability, and life history characteristics of PS/GB yelloweye rockfish, support the understanding that it is extremely unlikely that any individuals of this species would be within the expected range of this action's effect on fish. Therefore, the proposed action is not likely to adversely affect this species.

SR killer whales are uncommon in the action area November through March. Occurrence increases slightly in April and continues to increase slightly through the summer before decreasing again in September (NOAA and the Whale Museum 2019). Therefore, it is reasonably likely that SR killer whales may have been present within the action area during all phases of this project.

As described in the Federal Action section of this opinion, the 8 days pile driving during April 2020 included maximums of 13 minutes of vibratory installation and 3,299 pile strikes per day to install 9 30-inch diameter steel pipe piles (Tables 1 & 7). The action also included one day with 50 minutes of vibratory installation of 2 12-inch steel piles in September 2020, and 12 days of up to 8 hours of underwater wire cutting of a concrete block between mid-September and late-October 2020. The source levels and estimated ranges to the effects thresholds for SR killer whales present in Table 7 are based on the best available information, including the acoustic monitoring report for this project (Delphis 2020), recent acoustic assessments for similar projects (NMFS 2016; 2017c; 2018a), and other sources (CalTrans 2015; COE 2011 & 2018; DEA 2011; FHWA 2017; NMFS 2018b).

Table 7. Estimated maximum in-water source levels for project-related pile driving and wire saw use with the estimated ranges to the effects thresholds for SR killer whales.

Source	Acoustic Signature	Source Level	Threshold Range
Impact 30-inch Steel Pipe Piles	< 1.6 kHz Impulsive	227 dB_{peak}	230 dB_{peak} @ N/A
6 days with a maximum of 3,299 pile strikes per day.		199 dB_{SEL}	185 SEL_{CUM} @ 92 m
		194 dB_{RMS}	160 dB_{RMS} @ 185 m
Vibrate 30-inch Steel Pipe Piles	< 2.5 kHz Non-Impulsive	221 dB_{peak}	230 dB_{peak} @ N/A
8 days with a maximum of 13 minutes of vibratory noise/day.		194 dB_{SEL}	198 SEL_{CUM} @ 5 m
		196 dB_{RMS}	120 dB_{RMS} @ 117 Km
Wire Saw	< 1 kHz Non-Impulsive	189 dB_{peak}	206 dB_{peak} @ N/A
12 days with up to 8 hours of sawing per day		174 dB_{SEL}	198 dB SEL_{CUM} @ 0.3 m
		174 dB_{RMS}	120 dB_{RMS} @ 3,981 m
Vibrate 12-inch Steel Pipe Piles	< 2.5 kHz Non-Impulsive	186 dB_{peak}	206 dB_{peak} @ N/A
1 day with 50 minutes of installation.		170 dB_{SEL}	198 dB SEL_{CUM} @ 0.2 m
		170 dB_{RMS}	120 dB_{RMS} @ 2,154 m

The best available information indicate that project-related in-water noise capable of eliciting behavioral responses in whales theoretically extended as far as 73 miles (117 Km) from the project site during vibratory driving of the 30-inch steel piles. Because the ensonified area would be limited to in-water areas that are within line of sight of the project site and not blocked by intervening landmasses, that would have predominantly included the waters of the Georgia Strait west of the project site, but also included a very narrow swath of water that extended to the south-southwest through Rosario Strait to Port Townsend on the Olympic Peninsula, another narrow swath of water that extended into Canadian waters west to Sidney on Vancouver Island, and a third swath that extended into Canadian waters about 73 miles north-northwest of the project site. However, given the relatively high ambient noise levels that typically occur in the area (Bassett et al. 2010), project-related noise below 130 dB_{RMS} were probably undetectable by whales and other marine mammals, suggesting that non-impulsive project-related noise was undetectable beyond about 16 miles (25.12 Km) from the site.

The best available information indicate that no killer whales were injured by exposure to project-related noise. Peak noise levels were below the threshold for injury in SR killer whales (NMFS 2018b), and an exposed killer whale would have had to remain within 302 feet (92 m) of impact diving for the entire period of the most intense impact driving (3,299 strikes on April 15) or within 16 feet (5 m) of vibratory diving for the entire period of the longest vibratory driving days (13 minutes on April 4 and 14) in order to be injured by accumulated sound energy. Impulsive noise from impact driving attenuated to the 160 dB_{RMS} threshold for the onset of behavioral disturbance at about 202 yards (185 m) from the site. Detectable non-impulsive noise may have extended as far as 16 miles during vibratory work. Additionally, marine mammal observers were posted during all pile driving events to ensure that no marine mammals were within about 3,300 yards (3,000 m) of the project site during pile driving, and no SR killer whales were observed at any range during any of the pile driving events.

As summarize in Tables 1 and 8, the project caused 8 days of pile driving noise that consisted of 1 to 5 brief and discontinuous periods of in-water noise per day, the longest lasting about 1 hour, and the majority lasting less than half an hour. The first 5 days each included 1 or 2 events. One event lasted 49 minutes, 2 lasted about 30 minutes, and the remained 4 events lasted 2 to 8 minutes each. April 13 included 3 events; 61, 55, and 19 minutes. April 14 included 4 events; 62, 28, 25, and 5 minutes. The last day included 5 events, 54, 44, 32, 4, and 3 minutes. The project also included 2 25-minute periods of vibratory pile installation, and 12 days with up to 8 hours of underwater wire cutting (Table 8).

Table 8. Summary of per-day pile driving and wire saw cutting activity, with the reported work periods identified using the 24-hour clock system.

Date	∑ Vibratory	Timing	∑ Impacts	Timing
04/04/2020	13 minutes	1807-1835	0	N/A
04/06/2020	3 minutes	1311-1314	141	1815-1818
04/07/2020	11 minutes	1504-1508	719	1601-1619
04/08/2020	2 minutes	1317-1319	1,141	1430-1519
04/10/2020	3 minutes	1247-1317	0	N/A
04/13/2020	7 minutes	1329-1348	2,580	1014-1115 & 1452-1547
04/14/2020	13 minutes	1503-1508 & 1742-1800	3,105	0845-0947 & 1840-1905
04/15/2020	8 minutes	1123-1155 & 1553-1556	3,299	0810-0814 & 1232-1316 & 1646-1740
09/04/2020	50 minutes	2 25-minute periods	0	N/A
09/05-19/2020	Duration unreported. Assume up to 480 minutes of non-impulsive wire saw daily.		Timing unreported. Assume 0800 - 1600 daily.	

No killer whales were observed at any distance from the project site during the entire period. Further, if any SR killer whales were close enough to hear and respond to project-related noise, the most they experienced likely consisted of infrequent and brief periods of low-level acoustic masking. If any had approached to within about 202 yards (185 m) of the area during impact pile driving , they may have also experienced temporary minor avoidance of the area, but there is no evidence of that occurrence (Petrogas 2020f). The best available information indicates that the possible exposure of SR killer whales to project-related pile driving noise would have caused no impacts on their fitness, and it would have caused no meaningful impacts on their normal behaviors.

The only other project-related effects would have been limited temporary minor impacts on water quality within about 300 feet of the project site, and possible trophic effects through impacts on Chinook salmon. The water quality impacts were too minor to cause detectable effects on large animals such as killer whales, and it is extremely unlikely that any individuals approached close enough to the ongoing work to be exposed to the affected waters. Finally, because the proposed action would cause no population-level effects on the Chinook salmon that are their main prey resource (Section 2.5), the action would cause no measurable trophic effects on SR killer whales. Therefore, the action did not adversely affect SR killer whales.

2.12.2 Effects on Critical Habitat

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

The action area extends about 16 miles from the Petrogas Pier for its potential effects on marine mammals. The entire action area has been excluded from designation as critical habitat for PS steelhead. The nearest designated critical habitat for PS/GB yelloweye rockfish is about 9,000 feet northwest of the Petrogas Pier. As described in the analysis of action's effects (Section 2.5), project-related stressors caused no measurable effects on fish or their habitat resources beyond about 6,063 feet during pile driving, and 300 feet during all other activities. Therefore, the proposed action did not adversely affect designated critical habitat for PS/GB yelloweye rockfish.

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

1. Water quality to support growth and development
   The proposed action caused short-term minor effects, and long-term minor beneficial effects on water quality. It caused no measurable changes in water temperature and salinity, but in-water work briefly introduced low-levels of turbidity and contaminants that would be undetectable beyond about 300 feet of the pier and would not persist past several hours following the end of each work day. The removal of 45 creosote-treated timber piles would cause a long-term minor reduction of ongoing PAH contamination at the pier.

2. Prey species of sufficient quantity, quality, and availability to support individual growth, reproduction, and development, as well as overall population growth
   The proposed action would cause long-term extremely minor effects on prey availability. Action-related impacts would annually injure very low numbers of juvenile Chinook salmon (primary prey), but the impacts would be too small to cause population-level effects on that species. Therefore, it would cause no detectable reduction in prey availability.

3. Passage conditions to allow for migration, resting, and foraging
   The proposed action caused short-term minor effects on passage conditions. Over 8 days, detectable pile driving noise radiated about 16 miles into Georgia Strait. At most, exposure to the noise caused brief episodic periods of low-level acoustic masking in any SR killer whales that may have heard it, but it is extremely unlikely that the exposure caused any measurable effects on migration or access to important habitat resources.

Therefore, the proposed action did not adversely affect SR killer whale critical habitat.

For the reasons expressed immediately above, the NMFS concurs with the COE's determination that the proposed action is not likely to adversely affect ESA-listed PS steelhead, PS/GB yelloweye rockfish and their designated critical habitat, and SR killer whales and their designated critical habitat.

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

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

This analysis is based, in part, on the EFH assessment provided by the COE and on the descriptions of EFH for Pacific Coast Salmon (Pacific Fishery Management Council [PFMC] 2014), Pacific Coast Groundfish (PFMC 2005), and Coastal Pelagic Species (PFMC 1998) 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 project site located in the marine waters of the Strait of Georgia, northwest of the City of Bellingham, Washington (Figure 1). The action area includes waters and substrates that have been designated as EFH for various life-history stages of Pacific Coast Salmon, Pacific Coast Groundfish, and Coastal Pelagic Species. The action area also includes areas that qualify as habitat areas of particular concern (HAPC).

Marine EFH for Pacific Coast Salmon is identified and described in Appendix A to the Pacific Coast salmon fishery management plan (PFMC 2014). The major components of marine EFH are: Estuarine rearing; Ocean rearing; and juvenile and adult migration. The important features of this EFH are: (1) good water quality; (2) cool water temperatures; (3) abundant prey species and forage base (food); (4) connectivity with terrestrial ecosystems; and [5] adequate depth and habitat complexity including marine vegetation and algae in estuarine and near-shore habitats. Pacific Coast Salmon HAPC include: Complex channels and floodplain habitats; Thermal refugia; Spawning habitat; Estuaries; and Marine and estuarine submerged aquatic vegetation.

Pacific Coast Groundfish EFH is identified as: All marine waters and substrate from mean higher high water (MHHW) or the upriver extent of saltwater intrusion out to depths less than or equal to 11,484 feet (3,500 m); Certain specifically identified seamounts in depths greater than

11,484 feet; and Areas designated as HAPCs not already identified by the above criteria (PFMC 2005). Pacific Coast Groundfish HAPC includes: Estuaries; Canopy Kelp; Seagrass; Rocky Reefs; and Areas of interest. For Coastal Pelagic Species, EFH is identified as all marine and estuarine waters from the shoreline to the offshore limits of the exclusive economic zone (EEZ) and above the thermocline where sea surface temperatures range between 10°C to 26°C (PFMC 1998).

Succinct identification of specific habitat features that are necessary to support the full life cycles of Groundfish and Pelagic Species are absent from their respective EFH descriptions. However, the important features identified for Salmon EFH effectively address the habitat features that are necessary to support the full life cycle for all three species groups that may be affected by the proposed action. Therefore, the important features of Salmon EFH are used below to assess the impacts on EFH for all three species groups.

3.2 Adverse Effects on Essential Fish Habitat

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

1. Good water quality: The proposed action caused a mix of periodic short-term minor adverse effects and long-term minor beneficial effects on this attribute. The action caused no changes in salinity, but caused brief periods of increased turbidity and low levels of work-related contaminants. Conversely, the removal of 45 creosote-treated timber piles is likely to slightly reduce ongoing PAH contamination at the site. Detectable effects would be limited to the area within about 300 feet of the southwest end of the pier, with work-related impacts ending a low number of hours after work stopped.

2. Cool water temperatures: No changes occurred.

3. Abundant prey species and forage base: The proposed action caused long term minor adverse effects on this attribute. Project-related work mobilized relatively small amounts of contaminated sediments that would contaminate benthic invertebrates that are forage resources for juvenile salmon and rockfish. Sediment distribution was limited to the area within 300 feet around the southwest end of the pier, with detectable levels of contaminants expected to decrease over several years.

4. Connectivity with terrestrial ecosystems: No changes occurred.

5. Adequate depth and habitat complexity including marine vegetation and algae in estuarine and near-shore habitats: No changes occurred.

Estuaries and marine SAV are the only HAPC likely to be affected by the proposed action. All effects on these HAPC are identified above at 1 and 3.

3.3 Essential Fish Habitat Conservation Recommendations

The NMFS knows of no reasonable measures that the COE could take to reduce the proposed action's effects on the good water quality attribute because all work related to the proposed action has already been completed. However, pursuant to MSA (§305(b)(4)(A)), the NMFS offers the following conservation recommendation to reduce the proposed action's impacts on the abundant prey species and forage base attribute of EFH for Pacific Coast Salmon, Pacific Coast Groundfish, and Coastal Pelagic Species.

1. The COE should encourage the applicant to cap exposed contaminated sediments with clean fill material that is appropriate for the project site.

3.4 Statutory Response Requirement

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

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

3.5 Supplemental Consultation

The COE 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 is the COE. Other users could include Petrogas LLC., WDFW, the government and citizens of Whatcom County, and Native American tribes. Individual copies of this Opinion were provided to the COE. The document will be available within two weeks at the NOAA Library Institutional Repository [https://repository.library.noaa.gov/welcome]. The format and naming adheres to conventional standards for style.

4.2 Integrity

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

4.3 Objectivity

Information Product Category: Natural Resource Plan

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

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

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

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

5. REFERENCES

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

Bassett, C., J. Thomson, and B. Polagye. 2010. Characteristics of underwater ambient noise at a proposed tidal energy site in Puget Sound. In Proceedings of the Oceans 2010 Conference, September 23–25, Seattle WA. Presentation Slides. 15 pp.

Bax, N. J., E. O. Salo, B. P. Snyder, C. A. Simenstad, and W. J. Kinney. 1978. Salmonid outmigration studies in Hood Canal. Final Report, Phase III. January - July 1977, to U.S. Navy, Wash. Dep. Fish., and Wash. Sea Grant. Fish. Res. Inst., Univ. Wash., Seattle, WA. FRI-UW-7819. 128 pp.

Beitinger, T.L. and L. Freeman. 1983. Behavioral avoidance and selection responses of fishes to chemicals. In: Gunther F.A., Gunther J.D. (eds) Residue Reviews. Residue Reviews, vol 90. Springer, New York, NY.

Berg, L. and T.G. Northcote. 1985. Changes in Territorial, Gill-Flaring, and Feeding Behavior in Juvenile Coho Salmon (*Oncorhynchus kisutch*) Following Short-Term Pulses of Suspended Sediment. Canadian Journal of Fisheries and Aquatic Sciences 42: 1410-1417.

Bjornn, T. C., and D. W. Reiser. 1991. Habitat requirements of salmonids in streams. American Fisheries Society Special Publication 19:83-139.

Bloch, P. 2010. SR 520 Test Pile Turbidity Monitoring Technical Memorandum. Washington State Department of Transportation. Olympia, WA. July 19, 2010. 10 pp.

Brennan, J. S., K. F. Higgins, J. R. Cordell, and V. A. Stamatiou. 2004. Juvenile Salmon Composition, Timing, Distribution, and Diet in Marine Nearshore Waters of Central Puget Sound, 2001-2002. Prepared for the King County Department of Natural Resources and Parks, Seattle, WA.

Brette, F., B. Machado, C. Cros, J.P. Incardona, N.L. Scholz, and B.A. Block. 2014. Crude Oil Impairs Cardiac Excitation-Contraction Coupling in Fish. Science Vol 343. February 14, 2014. 10.1126/science.1242747. 5 pp.

Broadhurst, G. 1998. Puget Sound Nearshore Habitat Regulatory Perspective: A Review of Issues and Obstacles. Puget Sound/Georgia Basin International Task Force Work Group on Nearshore Habitat Loss for Coastal Training Program by Elliott Menashe, Greenbelt Consulting. 2004.

Burns, R. 1985. The shape and forms of Puget Sound. Published by Washington Sea Grant, and distributed by the University of Washington Press, 1985. ISBN: 0295961848. 100 pp.

CalTrans. 2015. Technical Guidance for Assessment and Mitigation of the Hydroacoustic Effects of Pile Driving on Fish. Including Appendix 1 - Compendium of Pile Driving Sound Data. Division of Environmental Analysis California Department of Transportation, 1120 N Street Sacramento, CA 95814. November 2015. 532 pp.

Campbell Scientific, Inc. 2008. Comparison of Suspended Solids Concentration (SSC) and Turbidity. Application Note Code: 2Q-AA. April 2008. 5 pp.

Carr, M.H. 1983. Spatial and temporal patterns of recruitment of young-of-the-year rockfishes (genus Sebastes) into a central California kelp forest. Master's thesis. San Francisco State Univ., Moss Landing Marine Laboratories, Moss Landing, CA.

Codarin, A., L.E. Wysocki, F. Ladich, and M. Picciulin. 2009. Effects of ambient and boat noise on hearing and communication in three fish species living in a marine protected area (Miramare, Italy). Marine Pollution Bulletin 58 (2009) 1880–1887.

Corps of Engineers, U.S. Army (COE). 2011. Snohomish River Dredging – Sound Pressure Levels Associated with Dredging – Acoustic Monitoring Report Final. Prepared by: Science Applications International Corporation Bothell, Washington and RPS/Evans-Hamilton, Inc. Seattle, Washington. May 31, 2011. 68 pp.

COE. 2015. Biological Evaluation, Continued Use of Multiuser Dredged Material Disposal Sites in Puget Sound and Grays Harbor. Seattle District, Seattle, Washington. June. 100 pp.

COE. 2018. Supplemental Environmental Assessment – Removal of Concrete Sill – U.S. Marine Corps Support Facility – Blount Island, Duval County, Jacksonville, Florida. [COE] Jacksonville District. August 2018. 42 pp.

COE. 2020a. NWS-2019-1054 Petrogas Pacific LLC (Damaged Dolphin Replacement) (UNCLASSIFIED). email from R. Perry to report pier damage and ask about coverage under existing BO. January 9, 2020. 2 pp.

COE. 2020b. ESA Consultation Request – NWS-2018-318 – NWS-2019-1054 – Petrogas Pacific LLC. January 16, 2020. 2 pp.

COE. 2018c. Memorandum for the Services (MFS) Reference Number: NWS-2019-1054 – Petrogas Pacific LLC. January 16, 2020. 4 pp.

COE. 2020d. Emergency Formal Consultation Request for NWS-2019-1054, Petrogas Pacific LLC (UNCLASSIFIED). email from R. Perry to revise request to re-initiate consultation to request a separate emergency consultation, with 7 attachments. January 16, 2020. 1 p.

COE. 2020e. Request for Comments on EMERGENCY Authorization, Re: NWS-2019-1054 Petrogas Pacific LLC (Mooring Dolphin Replacement) (UNCLASSIFIED). email from R. Perry to issue Emergency NWP 3 authorization for NWS-2019-1054, Petrogas Pacific, LLC, with attached drawings. January 16, 2019. 3 pp.

COE. 2020f. NWS-2019-1054 Petrogas Pacific LLC (Mooring Dolphin Replacement) (UNCLASSIFIED). email from R. Perry to request revision of the work window. April 9, 2020. 1 p.

COE. 2020g. NWS-2019-1054 Petrogas Pacific LLC (Mooring Dolphin Replacement) (UNCLASSIFIED). email from R. Perry to provide As-Built Information, with 4 attachments. June 11, 2020. 1 p.

COE. 2020h. FW: [Non-DoD Source] NWS-2019-1054 Petrogas Pacific LLC (Mooring Dolphin Replacement) As-Built Report and Monitoring Report (UNCLASSIFIED). email from R. Perry to provide additional information. July 24, 2020. 5 pp.

COE. 2020i. NWS-2019-1054 Petrogas Pacific LLC (Mooring Dolphin Replacement) (UNCLASSIFIED). email from R. Perry to provide project details and confirm draft RPMs etc. in the NMFS Biological opinion. July 31, 2020. 9 pp.

COE. 2020j. RE: FW: FW: [Non-DoD Source] Petrogas Pacific LLC Mooring Dolphin Replacement (NWS-2019-1054). email from R. Perry to provide a revised As-Built Report. November 10, 2020. 4 pp.

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

Crozier, L. G., M. D. Scheuerell, and E. W. Zabel. 2011. Using Time Series Analysis to Characterize Evolutionary and Plastic Responses to Environmental Change: A Case Study of a Shift Toward Earlier Migration Date in Sockeye Salmon. *The American Naturalist* 178 (6): 755-773.

David Evans and Associates, Inc. (DEA). 2011. Columbia River Crossing Test Pile Project – Hydroacoustic Monitoring – Final Report. Agreement Number Y-9246, Task AH, Amendment No. 7. July 2011. 256 pp.

Delphis Technical Support and Solutions, LLC. (Delphis). 2020. Underwater Sound Levels Associated With Pile Driving - Petrogas Mooring Dolphin Emergency Replacement - Ferndale, Washington. For: Culbertson Marine Anacortes, WA. By: Delphis, 13332 69th Dr. SE, Snohomish, WA 98296. DTSS Project No. DTSS 202005. Corps Reference Number: NWS-2019-1054. April 2020. 90 pp.

Dethier, M.N., W.W. Raymond, A.N. McBride, J.D. Toft, J.R. Cordell, A.S. Ogston, S.M. Heerhartz, and H.D. Berry. 2016. Multiscale impacts of armoring on Salish Sea shorelines: Evidence for cumulative and threshold effects. Estuarine, Coastal and Shelf Science 175 (2016) 106-117.

Dominguez, F., E. Rivera, D. P. Lettenmaier, and C. L. Castro. 2012. Changes in Winter Precipitation Extremes for the Western United States under a Warmer Climate as Simulated by Regional Climate Models. *Geophysical Research Letters* 39(5).

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

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

Ellison, C.A., R.L. Kiesling, and J.D. Fallon. 2010. Correlating Streamflow, Turbidity, and Suspended-Sediment Concentration in Minnesota's Wild Rice River. 2nd Joint Federal Interagency Conference, Las Vegas, NV, June 27 - July 1, 2010. 10 pp.

Environmental Security Technology Certification Program (ESTCP). 2016. Evaluation of Resuspension from Propeller Wash in DoD Harbors. ER-201031. SPAWARSYSCEN Pacific, 53560 Hull Street, San Diego, CA 92152–5001. May 2016. 53 pp.

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.

Federal Highway Administration (FHWA). 2017. On-line Construction Noise Handbook – Section 9.0 Construction Equipment Noise Levels and Ranges. Updated: June 28, 2017. Accessed March 5, 2019 at: https://www.fhwa.dot.gov/environment/noise/construction_noise/handbook/handbook09.cfm

Feist, B.E., E.R. Buhle, P. Arnold, J.W. Davis, and N.L. Scholz. 2011. Landscape ecotoxicology of coho salmon spawner mortality in urban streams. Plos One 6(8):e23424.

Forest Ecosystem Management Assessment Team (FEMAT). 1993. Forest ecosystem management: An ecological, economic, and social assessment. Report of the Forest Ecosystem Management Assessment Team. 1993-793-071. U.S. Gov. Printing Office.

Gobel, P., C. Dierkes, & W.C. Coldewey. 2007. Storm water runoff concentration matrix for urban areas. Journal of Contaminant Hydrology, 91, 26–42.

Good, T.P., June, J.A, Etnier, M. A, and G. Broadhurst. 2010. Derelict fishing nets in Puget Sound and the Northwest Straits: Patterns and threats to marine fauna. Marine Pollution Bulletin 60 (2010) 39-50.

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

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 salmoides*). Aquatic Conservation: Marine and Freshwater Ecosystems. 18:1315-1324.

Greene, C. and A. Godersky. 2012. Larval rockfish in Puget Sound surface waters. Northwest Fisheries Science Center. December 27, 2012. 16 pp.

Halderson, L. and L.J. Richards. 1987. Habitat use and young of the year copper rockfish in British Columbia. In Proc. In. Rockfish Symp. Anchorage, Alaska, pages. 129 to 141. Alaska Sea grant Rep. 87-2, Fairbanks 99701.

Hastings, M.C., and A. N. Popper. 2005. Effects of sound on fish. Final Report # CA05-0537 – Project P476 Noise Thresholds for Endangered Fish. For: California Department of Transportation, Sacramento, CA. January 28, 2005, August 23, 2005 (Revised Appendix B). 85 pp.

Hayden-Spear, J. 2006. Nearshore habitat associations of young-of-year copper (*Sebastes caurinus*). In Heifetz et al. 2007.

Heerhartz, S.M. and J.D. Toft. 2015. Movement patterns and feeding behavior of juvenile salmon (*Oncorhynchus* spp.) along armored and unarmored estuarine shorelines. Enviro. Biol. Fishes 98, 1501-1511.

Heifetz, J., J. DiCosimo, A.J. Gharrett, M.S. Love, V.M. O'Connell, and R.D. Stanley (editors). 2007. Biology, Assessment, and Management of North Pacific Rockfishes. Lowell Wakefield Fisheries Symposium. ISBN: 978-1-56612-114-9. DOI: https://doi.org/10.4027/bamnpr.2007. 560 pp.

Hicks, M. 1999. Evaluating criteria for the protection of aquatic life in Washington's surface water quality standards (preliminary review draft). Washington State Department of Ecology. Lacey, Washington. 48p.

Hicks, B. J., J. D. Hall, P. A. Bisson, and J. R. Sedell. 1991. Responses of salmonids to habitat change. American Fisheries Society Special Publication 19:483-519.

Hood Canal Coordinating Council (HCCC). 2005. Hood Canal & Eastern Strait of Juan de Fuca summer chum salmon recovery plan. Version November 15, 2005. 339 pp.

Hunter, M.A. 1992. Hydropower flow fluctuations and salmonids: A review of the biological effects, mechanical causes, and options for mitigation. Washington Department of Fisheries. Technical Report No. 119. Olympia, Washington.

Incardona, J.P., T.K. Collier, and N.L. Scholz. 2004. Defects in cardiac function precede morphological abnormalities in fish embryos exposed to polycyclic aromatic hydrocarbons. Toxicology and Applied Pharmacology 196:191-205.

Incardona, J.P., M.G. Carls, H. Teraoka, C.A. Sloan, T.K. Collier, and N.L. Scholz. 2005. Aryl hydrocarbon receptor-independent toxicity of weathered crude oil during fish development. Environmental Health Perspectives 113:1755-1762.

Incardona, J.P., H.L. Day, T.K. Collier, and N.L. Scholz. 2006. Developmental toxicity of 4-ring polycyclic aromatic hydrocarbons in zebrafish is differentially dependent on AH receptor isoforms and hepatic cytochrome P450 1A metabolism. Toxicology and Applied Pharmacology 217:308-321.

Independent Scientific Advisory Board (ISAB, editor). 2007. Climate change impacts on Columbia River Basin fish and wildlife. In: Climate Change Report, ISAB 2007-2. Independent Scientific Advisory Board, Northwest Power and Conservation Council. Portland, Oregon.

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

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

Killgore, K.J, L.E. Miranda, C.E. Murphy, D.M. Wolff, J.J. Hoover, T.M. Keevin, S.T. Maynord, and M.A. Cornish. 2011. Fish Entrainment Rates through Towboat Propellers in the Upper Mississippi and Illinois Rivers. Transactions of the American Fisheries Society, 140:3, 570-581, DOI: 10.1080/00028487.2011.581977.

Kondolf, G.M. 1997. Hungry water: Effects of dams and gravel mining on river channels. Environmental Management 21(4):533-551.

Kunkel, K. E., L. E. Stevens, S. E. Stevens, L. Sun, E. Janssen, D. Wuebbles, K. T. Redmond, and J. G. Dobson. 2013. Regional Climate Trends and Scenarios for the U.S. National Climate Assessment: Part 6. *Climate of the Northwest U.S. NOAA Technical Report NESDIS 142-6*. 83 pp. National Oceanic and Atmospheric Administration, National Environmental Satellite, Data, and Information Service, Washington, D.C.

Landrum, P.F., and D. Scavia. 1983. Influence of sediment on anthracene uptake, depuration, and biotransformation by the amphipod Hyalella azteca. Canada. J. Fish. Aquatic Sci. 40:298-305.

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 (eds.). Polynuclear aromatic hydrocarbons: mechanisms, methods and metabolism. Battelle Press, Columbus, Ohio.

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

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

Love, M.S., M.H. Carr, and L.J. Haldorson. 1991. The ecology of substrate-associated juveniles of the genus Sebastes. Environ. Biol. Fishes. Volume 30, pages 225 to 243.

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

Lunz, J.D. and M.W. LaSalle. 1986. Physiochemical alterations of the environment associated with hydraulic cutterhead dredging. Am. Malacol. Bull. Spec. Ed. No. 3: 31-36.

Lunz, J.D., M.W. LaSalle, and L. Houston. 1988. Predicting dredging impacts on dissolved oxygen. Pp.331-336. In Proceedings First Annual Meeting Puget Sound Research, Puget Sound Water Quality Authority, Seattle, WA.

Mantua, N., I. Tohver, and A. Hamlet. 2009. Impacts of Climate Change on Key Aspects of Freshwater Salmon Habitat in Washington State. *In* The Washington Climate Change Impacts Assessment: Evaluating Washington's Future in a Changing Climate, edited by

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

Matthews, K.R. 1989. A comparative study of habitat use by young-of-the year, sub-adult, and adult rockfishes on four habitat types in Central Puget Sound. Fishery Bulletin, U.S. Volume 88, pages 223-239.

McCain, B., D.C. Malins, M.M. Krahn, D.W. Brown, W.D. Gronlund, L.K. Moore, and S-L. Chan. 1990. Uptake of Aromatic and Chlorinated Hydrocarbons by Juvenile Chinook Salmon (*Oncorhynchus tshawytscha*) in an Urban Estuary. Arch. Environ. Contam. Toxicol. 19, 10-16 (1990).

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. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-42. June 2000. 156 pp.

McIntyre, J.K, D.H. Baldwin, D.A. Beauchamp, and N.L. Scholz. 2012. Low-level copper exposures increase visibility and vulnerability of juvenile coho salmon to cutthroat trout predators. Ecological Applications, 22(5), 2012, pp. 1460–1471.

McMahon, T.E., and G.F. Hartman. 1989. Influence of cover complexity and current velocity on winter habitat use by juvenile coho salmon (*Oncorhynchus kisutch*). *Canadian Journal of Fisheries and Aquatic Sciences* 46: 1551–1557.

Meadore, J.P., F.C. Sommers, G.M. Ylitalo, and C.A. Sloan. 2006. Altered growth and related physiological responses in juvenile Chinook salmon (*Oncorhynchus tshwaytscha*) from dietary exposure to polycyclic aromatic hydrocarbons (PAHs). Canadian Journal of fisheries and Aquatic Sciences. 63: 2364-2376.

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

Miller, B.S. and S.F. Borton. 1980. Geographical distribution of Puget Sound fishes: Maps and data source sheets. Univ. of Washington Fisheries Research Institute, 3 vols.

Moore, M. E., F. A. Goetz, D. M. Van Doornik, E. P. Tezak, T. P. Quinn, J. J. Reyes-Tomassini, and B. A. Berejikian. 2010. Early marine migration patterns of wild coastal cutthroat trout (*Oncorhynchus clarki clarki*), steelhead trout (*Oncorhynchus mykiss*), and their hybrids. PLoS ONE 5(9):e12881. Doi:10.1371/journal.pone.0012881. 10 pp.

Morton, J. W. 1976. Ecological effects of dredging and dredge spoil disposal: a literature review. Technical Paper 94. U.S. Fish and Wildlife Service. Washington D.C. 33 pp.

Mote, P.W., J.T. Abatzglou, and K.E. Kunkel. 2013. Climate: Variability and Change in the Past and the Future. In Climate Change in the Northwest: Implications for Our Landscapes, Waters, and Communities, edited by M.M. Dalton, P.W. Mote, and A.K. Snover, 41-58. Island Press, Washington, DC.

Mote, P.W, A. K. Snover, S. Capalbo, S.D. Eigenbrode, P. Glick, J. Littell, R.R. Raymondi, and W.S. Reeder. 2014. Ch. 21: Northwest. *In* Climate Change Impacts in the United States: The Third National Climate Assessment, J. M. Melillo, T.C. Richmond, and G.W. Yohe, Eds., U.S. Global Change Research Program, 487-513.

Mueller, G. 1980. Effects of Recreational River Traffic on Nest Defense by Longear Sunfish. Transactions of the American Fisheries Society. 109:248-251.

National Marine Fisheries Service (NMFS). 2006. Final Supplement to the Shared Strategy's Puget Sound Salmon Recovery Plan. Prepared by NMFS Northwest Region. November 17, 2006. 47 pp.

NMFS. 2016. Memorandum to the Record Re: WCR-2016-4831 Kozlowski Pier Construction, Sinclair Island, Washington – Acoustic Assessment for Planned Pile Driving and Drilling. September 22, 2016. 14 pp.

NMFS. 2017a. 2016 5-Year Review: Summary and Evaluation of Puget Sound Chinook Salmon, Hood Canal Summer-run Chum Salmon, and Puget Sound Steelhead. NMFS West Coast Region, Portland, Oregon. April 6, 2017. 98 pp.

NMFS. 2017b. Rockfish Recovery Plan: Puget Sound / Georgia Basin Yelloweye Rockfish (*Sebastes ruberrimus*) and Bocaccio (*Sebastes paucispinis*). NMFS West Coast Region, Protected Resources Divisions, Seattle, Washington. October 13, 2017. 164 pp.

NMFS. 2017c. Memorandum to the Record Re: WCR-2017-7942 Kitsap Transit Annapolis Ferry Dock Upgrade, Port Orchard, Washington – Acoustic Assessment for Planned Pile Extraction and Driving. November 8, 2017. 10 pp.

NMFS. 2018a. Memorandum to the Record Re: WCR-2017-7601 WA Parks Pier Replacement, Cornet Bay, Whidbey Island, Washington – Acoustic Assessment for Planned Pile Extraction and Driving, and for Recreational Boat Use at the Pier. March 26, 2018. 15 pp.

NMFS. 2018b. 2018 Revisions to: Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing (Version 2.0): Underwater Thresholds for Onset of Permanent and Temporary Threshold Shifts. U.S. Dept. of Commer., NOAA. NOAA Technical Memorandum NMFS-OPR-59, 167 pp.

NMFS. 2020. Re: FW: Request for Comments on EMERGENCY Authorization, Re: NWS-2019-1054 Petrogas Pacific LLC (Mooring Dolphin Replacement) (UNCLASSIFIED). e-mail from D. Hubner to agree with COE's March 20, 2020 request revise the in-water work window. March 23, 2020. 1 p.

National Oceanographic and Atmospheric Administration (NOAA). 2018. Navigational Chart for Strait of Juan de Fuca to Strait of Georgia. Chart No. 18421 52nd Ed., Jan. 2017. Last Correction: November 30, 2018. Accessed January 31, 2019 at: http://www.charts.noaa.gov/OnLineViewer/18421.shtml.

NOAA. 2020. Environmental Response Management Application – Pacific Northwest. On-line mapping application. Accessed on June 5, 2020 at: https://erma.noaa.gov/northwest/erma.html#/layers=1&x=122.88365&y=48.25510&z=8&panel=layer

NOAA and the Whale Museum. 2019. Southern Resident Killer Whale Sighting 1990-2018. The Whale Museum map of sightings of SR killer whales by month, based on data in Olson, J. 2019. Southern Resident Killer Whale Sighting Compilation 1948-2018.

Natural Resource Consultants, Inc. (NRC). 2014. Rockfish bycatch in shrimp pots and updated estimates of the magnitude of derelict shrimp pots in Puget Sound. Sub to: The Northwest Straits Foundation. Sub. By: NRC 4039 21st Ave. West, Ste. 404, Seattle, WA 98199-1252, U.S.A. August 29, 2014. 18 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 (eds.). Symposium: carcinogenic polynuclear aromatic hydrocarbons n the marine environment. U.S. Environ. Protection Agency Rep. 600/9-82-013.

Neo, Y.Y., J. Seitz, R.A. Kastelein, H.V. Winter, C. Cate, H. Slabbekoorn. 2014. Temporal structure of sound affects behavioural recovery from noise impact in European seabass. Biological Conservation 178 (2014) 65-73.

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

Northwest Fisheries Science Center (NWFSC). 2015. Status review update for Pacific salmon and steelhead listed under the Endangered Species Act: Pacific Northwest. December 21, 2015. 356 pp.

Orr, J. W., M.A. Brown, and D.C. Baker. 2000. Guide to Rockfishes (Scorpaenidae) of the Genera *Sebastes*, *Sebastolobus*, and *Adelosebastes* of the Northeast Pacific Ocean, Second Edition. NOAA Technical Memorandum NMFS-AFSC-117.

Pacific Fishery Management Council (PFMC). 1998. Description and identification of essential fish habitat for the Coastal Pelagic Species Fishery Management Plan. Appendix D to Amendment 8 to the Coastal Pelagic Species Fishery Management Plan. PFMC, Portland, Oregon. December 1998. 41 pp.

PFMC. 2005. Amendment 18 (bycatch mitigation program), Pacific Coast Groundfish Fishery Management Plan for the California, Oregon, and Washington groundfish fishery – Appendix B Part 3 – Essential Fish Habitat text Descriptions. PFMC, Portland, Oregon. November 2005. 361 pp.

PFMC. 2014. Appendix A to the Pacific Coast salmon fishery management plan, as modified by amendment 18 to the pacific coast salmon plan: identification and description of essential fish habitat, adverse impacts, and recommended conservation measures for salmon. PFMC, Portland, OR. September 2014. 196 p. + appendices.

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, Fish Management Division, Olympia, WA. September 2009. 190 pp.

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

Petrogas Pacific LLC (Petrogas). 2018. Petrogas Pier Maintenance Activities 2018-2023: Biological Evaluation. Based on the US Army Corps of Engineers, Seattle District's Biological Evaluation Informal ESA Consultation Version: May 2012. March 13, 2018. 85 pp.

Petrogas. 2020a. Biological Evaluation for Informal ESA Consultation for: NWS-2020-154 (Corps Reference Number) – Version: May 2012. January 8, 2020. 34 pp.

Petrogas. 2020b. [Vicinity Map and Project Drawings] Catwalk and Dolphin Repair – Ferndale, WA. Petrogas Pacific LLC, 3900 Bow Valley Square 2, 205 5th Ave. SW, Calgary, AB T2P 2V7 Canada. January 3, 2020. 4 pp.

Petrogas. 2020c. [Project Site Photographs] Petrogas Pier: Damage to South Mooring Dolphin and Walkway – Before and After. Undated, provided with consultation request. 2 pp.

Petrogas. 2020d. Petrogas Pier South Mooring Dolphin Emergency Repair – Marine Mammal Monitoring Plan. Undated, provided with consultation request. 4 pp.

Petrogas. 2020e. Petrogas Ferndale Wharf South Mooring Dolphin Replacement As-Built Report – Corps Reference Number: NWS-2019-1054. Prepared by Envoy Environmental Consulting. Undated Document sent as an Attachment to COE 2020g. 12 pp.

Petrogas. 2020f. Marine Mammal Monitoring Log - Petrogas. Observer logs dated April 6 through 15, 2020. Sent as an Attachment to COE 2020i. 7 pp.

Petrogas. 2020g. Petrogas Ferndale Wharf South Mooring Dolphin Replacement and Cleanup As-Built Report – Corps Reference Number: NWS-2019-1054. Prepared by Envoy Environmental Consulting. Undated Document sent as an Attachment to COE 2020j. 22 pp.

Petrogas. 2020h. Re: FW: FW: [Non-DoD Source] Petrogas Pacific LLC Mooring Dolphin Replacement (NWS-2019-1054). email from C. Carter to describe the final phase of work. December 3, 2020. 8 pp.

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 (2010) 125–132.

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

Rice, C.A., 2006. Effects of shoreline modification on a northern Puget Sound beach: microclimate and embryo mortality in surf smelt (*Hypomesus pretiosus*). Estuaries and Coasts 29: 63-71.

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, 37 pp.

Romberg, P. 2005. Recontamination Sources at Three Sediment Caps in Seattle. Proceedings of the 2005 Puget Sound Georgia Basin Research Conference. 7 pp.

Ruckelshaus, M., K. Currens, W. Graeber, R. Fuerstenberg, K. Rawson, N. Sands, and J. Scott. 2002. Planning ranges and preliminary guidelines for the delisting and recovery of the Puget Sound Chinook salmon evolutionarily significant unit. Puget Sound Technical Recovery Team. National Marine Fisheries Service, Northwest Fisheries Science Center. Seattle.

Sandahl, J.F., D. 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. 2007, 41, 2998-3004.

Scholik, A.R., and H.Y. Yan. 2002. Effects of boat engine noise on the auditory sensitivity of the fathead minnow, Pimephales promelas. Environmental Biology of Fishes. 63:203-209.

Schreiner, J. U., E. O. Salo, B. P. Snyder, and C. A. Simenstad. 1977. Salmonid outmigration studies in Hood Canal. Final Report, Phase II, to U.S. Navy, Fish. Res. Inst., Univ. Wash., Seattle, WA. FRI-UW-7715. 64 pp.

Sebastianutto, L., M. Picciulin, M. Costantini, and E.A. Ferrero. 2011. How boat noise affects an ecologically crucial behavior: the caser of territoriality in *Gobius cruentatus* (Gobiidae). Environmental Biology of Fishes. 92:207-215.

Shaffer, J. A. Doty, D. C., Buckley, R. M., and J. E. West. 1995. Crustacean community composition and trophic use of the drift vegetation habitat by juvenile sp1itnose rockfish *Sebastes diploproa*. Marine Ecology Progress Series. Volume 123, pages 13 to 21.

Shared Strategy for Puget Sound (SSPS). 2007. Puget Sound Salmon Recovery Plan – Volume 1. Shared Strategy for Puget Sound, 1411 4th Ave., Ste. 1015, Seattle, WA 98101. Adopted by NMFS January 19, 2007. 503 pp.

Simpson, S.D., A.N. Radford, S.L. Nedelec, M.C.O. Ferrari, D.P. Chivers, M.I. McCormick, and M.G. Meekan. 2016. Anthropogenic noise increases fish mortality by predation. Nature Communications 7:10544 DOI: 10.1038/ncomms10544 www.nature.com/naturecommunications February 5, 2016. 7 pp.

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

Sobocinski, K.L., J.R. Cordell, and C.A. Simenstad. 2010. Effects of shoreline modifications on supratidal macroinvertebrate fauna on Puget Sound, Washington beaches. Estuaries and Coasts (2010) 33: 699-711.

Spence, B.C., G.A. Lomnicky, R.M. Hughes, and R.P. Novitzki. 1996. An ecosystem approach to salmonid conservation. ManTech Environmental Research Services, Inc. Corvallis, Oregon. National Marine Fisheries Service, Portland, Oregon.

Spromberg, J.A, D.H. Baldwin, S.E. Damm, J.K. McIntyre, M. Huff, C.A. Sloan, B.F. Anulacion, J.W. Davis, and N.L. Scholz. 2015. Coho salmon spawner mortality in western US urban watersheds: bioinfiltration prevents lethal storm water impacts. Journal of Applied Ecology. DOI: 10.1111/1365-2264.12534.

Stadler, J.H., and D.P. Woodbury. 2009. Assessing the effects to fishes from pile driving: Application of new hydroacoustic criteria. 8 pp.
Tagal, M., K. C. Massee, N. Ashton, R. Campbell, P. P1esha, and M. B. Rust. 2002. Larval development of yelloweye rockfish, Sebastes ruberrimus. National Oceanic and Atmospheric Administration, Northwest Fisheries Science Center.
Tillmann, P. and D. Siemann. 2011. Climate Change Effects and Adaptation Approaches in Marine and Coastal Ecosystems of the North Pacific Landscape Conservation Cooperative Region. National Wildlife Federation.
Tonnes, D., M. Bhuthimethee, J. Sawchuk, N. Tolimieri, K. Andrews, and K. Nichols. 2016. Yelloweye rockfish (*Sebastes ruberrimus*), canary rockfish (*Sebastes pinniger*), and bocaccio (*Sebastes paucispinis*) of the Puget Sound/Georgia Basin. 5-Year Review: Summary and Evaluation. NMFS West Coast Region, Protected Resources Divisions, Seattle, Washington. April 2016. 131 pp.
Varanasi, U., E. Casillas, M.R. Arkoosh, T. Hom, D.A. Misitano, D.W. Brown, S.L. Chan, T.K. Collier, B.B. McCain, and J.E. Stein. 1993. Contaminant Exposure and Associated Biological Effects in Juvenile Chinook Salmon (Oncorhynchus tshawytscha) from Urban and Nonurban Estuaries of Puget Sound. NOAA Technical Memorandum NMFS-NWFSC-8. NMFS NFSC Seattle, WA. April 1993. 69 pp.
Virginia Institute of Marine Science (VIMS). 2011. Propeller turbulence may affect marine food webs, study finds. ScienceDaily. April 20, 2011. Accessed September 12, 2019 at: https://www.sciencedaily.com/releases/2011/04/110419111429.htm
Wainwright, T. C., and L. A. Weitkamp. 2013. Effects of climate change on Oregon Coast coho salmon: habitat and life-cycle interactions. *Northwest Science* 87(3): 219-242.
Washington, P. 1977. Recreationally important marine fishes of Puget Sound, Washington. NOAA/NMFS, Northwest and Alaska Fisheries Center. May 1977. 128 pp.
Washington State Department of Ecology (WDOE). 2010a. Focus on Shoreline Armoring. Shorelands and Environmental Assistance Program. Publication Number: 10-06-004. February 2, 2010 (Rev 2/11/10). 5 pp.
WDOE. 2010b. Focus on Toxic Chemicals in Puget Sound – Water Quality Program – Reports reconfirm surface runoff as leading source of toxics in Puget Sound. Publication Number: 08-10-097 (Rev. January/2010). 2pp.
Washington State Department of Fish and Wildlife (WDFW). 2020a. SalmonScape. Accessed on June 5, 2020 at: http://apps.wdfw.wa.gov/salmonscape/map.html.
WDFW. 2020b. WDFW Conservation Website – Species – Salmon in Washington – Chinook. Accessed on June 5, 2020 at: https://fortress.wa.gov/dfw/score/score/species/chinook.jsp?species=Chinook
WDFW. 2020c. Species & Ecosystem Science Webpage - Marine Beach Spawning Fish Ecology. Accessed on June 5, 2020 at: https://wdfw.maps.arcgis.com/home/webmap/viewer.html?webmap=19b8f74e2d41470cbd80b1af8dedd6b3&extent=-126.1368,45.6684,-119.6494,49.0781
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.
Werme C., J. Hunt, E. Beller, K. Cayce, M. Klatt, A. Melwani, E. Polson, and R. Grossinger. 2010. Removal of Creosote-Treated Pilings and Structures from San Francisco Bay. Prepared for the California State Coastal Conservancy. Contribution No. 605. San Francisco Estuary Institute, Oakland, California. December 2010. 247 pp.
Winder, M. and D. E. Schindler. 2004. Climate change uncouples trophic interactions in an aquatic ecosystem. *Ecology* 85: 2100–2106.

Xie, Y.B., C.G.J. Michielsens, A.P. Gray, F.J. Martens, and J.L. Boffey. 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.