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

Refer to NMFS No.:
WCR-2016-6057

January 26, 2018

Evan R. Lewis, Chief
Environmental and Cultural Resources Branch
Corps of Engineers, Seattle District
Post Office Box 3755
Seattle, Washington 98124-3755

Re: Endangered Species Act Section 7 Formal Consultation and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Consultation for U.S Army Corps of Engineers' (COE) proposed 25-year maintenance dredging program for eight Federally-Authorized Navigation Channels in western Washington State.

Dear Mr. Lewis:

Thank you for your letter of December 16, 2016, 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) maintenance dredging program for eight federally-authorized navigation channels around the Puget Sound and along the west coast of Washington State. Thank you, also, for your request for consultation pursuant to the essential fish habitat (EFH) provisions in Section 305(b) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA)(16 U.S.C. 1855(b)) for this action.

The enclosed document contains the biological opinion (Opinion) prepared by NMFS pursuant to section 7(a)(2) of the ESA on the effects of the proposed action. In this Opinion, NMFS concludes that the proposed action is likely to adversely affect but not likely to jeopardize the continued existence of Puget Sound Chinook salmon, Puget Sound steelhead, Southern eulachon, and Southern green sturgeon. NMFS also concludes that the proposed action is likely to adversely affect designated critical habitat for Puget Sound Chinook salmon, Hood Canal summer-run chum salmon, Puget Sound steelhead, Puget Sound/Georgia Basin bocaccio, and Southern green sturgeon but is not likely to result in the destruction or adverse modification of those designated critical habitats. In this Opinion, we also conclude that the proposed action is not likely to adversely affect any ESA-listed salmon from the Columbia and Willamette River evolutionarily significant units, and their designated critical habitats; Hood Canal Summer-run chum salmon; Puget Sound/Georgia Basin (PS/GB) bocaccio; PS/GB yelloweye rockfish and its designated critical habitat; seven ESA-listed marine mammal species; designated critical habitat for southern resident killer whales; four ESA-listed marine turtles; and designated critical habitat for leatherback turtles.

As required by section 7 of the ESA, NMFS has provided an incidental take statement with this Opinion. The incidental take statement describes reasonable and prudent measures NMFS considers necessary or appropriate to minimize the impact of incidental take associated with this action, and sets forth nondiscretionary terms and conditions that the 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.

This document also includes the results of our analysis of the action's likely effects on essential fish habitat (EFH) pursuant to Section 305(b) of the MSA. NMFS reviewed the likely effects of the proposed action on EFH, and concluded that the action would adversely affect designated EFH for Pacific Coast Salmon, Pacific Coast Groundfish, and Coastal Pelagic Species. Therefore, we have included the results of that review in Section 3 of this document.

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,

Barry A. Thom
Regional Administrator

cc: Nancy Gleason, COE

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

for the

Maintenance Dredging Program for Eight Federally-Authorized Navigation Channels
Puget Sound and along the West Coast of Washington State

NMFS Consultation Number: WCR-2017-6057

Action Agency: U.S. Army Corps of Engineers

Affected Species and 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*)					
Lower Columbia River	Threatened	No	No	N/A	N/A
Puget Sound (PS)	Threatened	Yes	No	Yes	No
Upper Willamette River	Threatened	No	No	N/A	N/A
chum salmon (*O. keta*)					
Columbia River	Threatened	No	No	N/A	N/A
Hood Canal Summer-run (HCSR)	Threatened	No	No	Yes	No
steelhead (*O. mykiss*) PS	Threatened	Yes	No	Yes	No
bocaccio (*Sebastes paucispinis*) Puget Sound /Georgia Basin (PS/GB)	Endangered	No	No	Yes	No
yelloweye rockfish (*S. ruberrimus*) PS/GB	Threatened	No	No	No	No
eulachon (*Thaleichthys pacificus*) Southern	Threatened	Yes	No	N/A	N/A
green sturgeon (*Acipenser medirostris*) Southern	Threatened	Yes	No	Yes	No
blue whales (*Balaenoptera musculus*)	Endangered	No	No	N/A	N/A
fin whale *(B. physalus)*	Endangered	No	No	N/A	N/A
humpback whales (*Megaptera novaeanglia*)					
Central America	Endangered	No	No	N/A	N/A
Mexico	Threatened	No	No	N/A	N/A
killer whales (*Orcinus orca*) Southern resident	Endangered	No	No	No	No
sei whales (*B. borealis*)	Endangered	No	No	N/A	N/A
sperm whales (*Physeter macrocephalus*)	Endangered	No	No	N/A	N/A
green sea turtle (*Chelonia mydas*) East Pacific	Threatened	No	No	N/A	N/A
leatherback sea turtles (*Dermochelys coriacea*)	Endangered	No	No	No	No

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?
loggerhead sea turtle (*Caretta caretta*) North Pacific Ocean	Endangered	No	No	N/A	N/A
olive Ridley sea turtles (*Lepidochelys olivacea*)	Threatened	No	No	N/A	N/A

N/A = not applicable. The action area is outside designated critical habitat, or critical habitat has not been designated.

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:

Barry A. Thom
Regional Administrator

Date: January 26, 2018

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LIST OF ACRONYMS

BA – Biological Assessment
BMP – Best Management Practices
CFR – Code of Federal Regulations
CH – Critical Habitat
CHART – Critical Habitat Analytical Review Team
COE – Corps of Engineers, US Army
DIP – Demographically Independent Population
DMMP – Dredged Material Management Program
DPS – Distinct Population Segment
DQA – Data Quality Act
EF – Essential Feature
EFH – Essential Fish Habitat
EPA –Environmental Protection Agency, US
ESA – Endangered Species Act
ESU – Evolutionarily Significant Unit
FR – Federal Register
HAPC – Habitat Area of Particular Concern
HUC – Hydrologic Unit Code
ITS – Incidental Take Statement
LW – Large Wood
MPG – Major Population Group
MSA – Magnuson-Stevens Fishery Conservation and Management Act
NMFS – National Marine Fisheries Service
NTU – Nephlometric Turbidity Units
Opinion – Biological Opinion
OWCO – Oregon Washington Coastal Office
PAH – Polycyclic Aromatic Hydrocarbons
PBF – Primary Biological Feature
PC – Pacific Coast
PCB – Polychlorinated Biphenyl
PCE – Primary Constituent Element
PFMC – Pacific Fishery Management Council
POC – Point Of Compliance
PS – Puget Sound
PS/GB – Puget Sound/Georgia Basin (bocaccio and yelloweye Rockfish)
PSSTRT – Puget Sound Steelhead Technical Recovery Team
PSTRT – Puget Sound Technical Recovery Team
RPM – Reasonable and Prudent Measure
SAV – Submerged Aquatic Vegetation
SMS – Sediment Management Standards
SQS – Sediment Quality Standards
SR – Southern Resident (Killer Whales)
USCG – United States Coast Guard
VSP – Viable Salmonid Population

WAC – Washington Administrative Code
WCR – Westcoast Region (NMFS)
WDFW – Washington State Department of Fish and Wildlife
WDNR – Washington State Department of Natural Resources
WDOE – Washington State Department of Ecology
WDOT – Washington State Department of Transportation
WQMP – Water Quality Monitoring Plan
WSF – Washington State Ferries

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 portions of this document in accordance with section 7(b) of the Endangered Species Act (ESA) of 1973 (16 USC 1531 *et seq*.), and implementing regulations at 50 CFR 402.

We also completed an essential fish habitat (EFH) consultation on the proposed action, in accordance with section 305(b)(2) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA) (16 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 (section 515 of the Treasury and General Government Appropriations Act for Fiscal Year 2001, Public Law 106-554). A complete record of this consultation is on file at the Oregon Washington Coastal Area Office.

1.2 Consultation History

On December 16, 2016, NMFS received a letter from the COE, requesting informal consultation for implementation of their maintenance dredging program for eight federally authorized navigation channels around the Puget Sound and along the west coast of Washington State, which would occur over the next 25 years. The consultation request included an enclosed biological assessment (BA) for the proposed action. As described in more detail in section 2 below, and in the US Army Corps of Engineers (COE) biological assessment (BA) for the proposed action, the eight channels considered in this consultation were all first constructed between 1892 and 1958, and the COE is tasked by Congress to conduct periodic maintenance dredging of those channels. The history of previous consultations with NMFS for dredging these channels is also described in the BA, as summarized here. All previous consultations with NMFS were done individually for each channel. The majority of the consultations were informal, including all of the most recent consultations. Numerous re-consultations have been completed for most of the channels, due to the expiration of the previous consultations, to account for project modifications, and/or for changes in the listing status for species within the action area. In geographic order, starting at Grays Harbor and working clockwise through the Puget Sound, the most recent consultations for the eight channels are: 1) the 2014 informal for Grays Harbor (WCR-2014-476); 2) none for Westhaven Cove Small Boat Basin; 3) the COE 2014 “No Effect” determination for Quillayute River; 4) the 2008 informal for Port Townsend Harbor (NWR-2008-4477); 5) the 2011 informal for Keystone Harbor (NWR-2011-1689); 6) the 2012 informal for the Swinomish Channel (NWR-2012-354); 7) the 2011 informal for Everett Harbor and the Snohomish River Channel (NWR-2011-3310); and 8) the 2011 informal for the Upper Duwamish Waterway (NWR-2011-2973).

On March 10, 2017, NMFS informed the COE that the proposed dredging would adversely affect listed species and/or critical habitat in at least four of the eight channels (Grays Harbor, Westhaven Cove, Everett Harbor and Snohomish River, and Upper Duwamish Waterway), and that formal consultation would be required. After that date, numerous e-mails and phone calls were exchanged between NMFS and the COE to request additional information and discuss thresholds for the onset of adverse effects as they pertained to specific dredging sites. Examples of requested additional information include clarification and/or correction of project details presented in the BA, details about the consultation history of the multi-user in-water dredge material disposal sites, and details about the hydrographic sonars that would be used as part of the proposed action. The COE and NMFS also considered whether or not to divide the proposed action into two actions; with the channels where dredging is likely to cause adverse effects being considered together in a formal consultation, and the remains sites considered together in an informal consultation. It was mutually decided to consider all eight sites together in a single formal consultation. NMFS received the last of the required additional information concerning the proposed action on September 30, 2017. Formal consultation was initiated on that date.

On October 13, 2017, NMFS informed the COE that we discovered information that argued against the COE's "No Effect" determination for the Quillayute River dredging site, and we requested that the COE provide a letter to remove that determination, and revise their species and critical habitat (CH) determinations to mirror those expressed in Table 2 below. Representatives from the COE and NMFS discussed NMFS's request by telephone on October 24, 2017. In that call, the COE told NMFS that they preferred to move forward with the formal consultation while maintaining their original effects determinations, understanding that the biological opinion would be contrary to the determinations expressed in their original letter. The COE and NMFS agreed to move forward with the formal consultation under that condition.

This Opinion is based on the review of: the COE's biological assessment (BA), supplemental materials, and responses to NMFS questions for the proposed action; recovery plans, status reviews, and CH designations for ESA-listed Puget Sound (PS) Chinook salmon, Hood Canal summer-run (HCSR) chum salmon, PS steelhead, Puget Sound/Georgia Basin (PS/GB) bocaccio, southern eulachon, and southern green sturgeon; published and unpublished scientific information on the biology and ecology of those species; and relevant scientific and gray literature (see Literature Cited). A complete record of this consultation is on file at the Oregon Washington Coastal Office (OWCO) in Lacey, Washington.

1.3 Proposed Action

"Action" means all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by Federal agencies (50 CFR 402.02). "Interrelated actions" are those that are part of a larger action and depend on the larger action for their justification. "Interdependent actions" are those that have no independent utility apart from the action under consideration (50 CFR 402.02). The proposed action would maintain the currently authorized conditions of existing navigation channels and the current level of vessel traffic. No changes in the type or frequency of vessel traffic in these channels would be caused by the proposed action. Therefore, there are no interdependent or interrelated activities associated with the proposed action.

The COE executes a program to maintain eight federally authorized navigation channels in Western Washington State, and has requested consultation with NMFS for implementation of that program for the next 25 years. The program includes periodically recurring work at: 1) Grays Harbor Navigation Channel; 2) Westhaven Cove Small Boat Basin; 3) Quillayute River Navigation Channel; 4) Port Townsend Harbor; 5) Keystone Harbor Federal Navigation Channel; 6) Swinomish Federal Navigation Channel; 7) Everett Harbor and Snohomish River Navigation Channel; and 8) the Upper Duwamish Waterway (Figure 1). The project description is based primarily on the COE BA (COE 2016a) and on additional information as cited.

Most of the work would be done through contracted commercial dredging companies with COE oversight. The COE would conduct the remainder. In addition to periodic dredging and disposal of the material, the program includes activities such as pre- and post-dredging hydrographic surveys of the channels, testing of channel sediments, and removal of navigation hazards and underwater obstructions done incidental to scheduled maintenance dredging. All action-related work would be done in compliance with the U.S. Army Corps of Engineers Standard Best management Practices for Dredging Operations (Appendix 1), the Water Quality Monitoring Plan for this action (Appendix 2), and the Conservation Measures listed on pages 69 and 70 in the COE BA for this action.

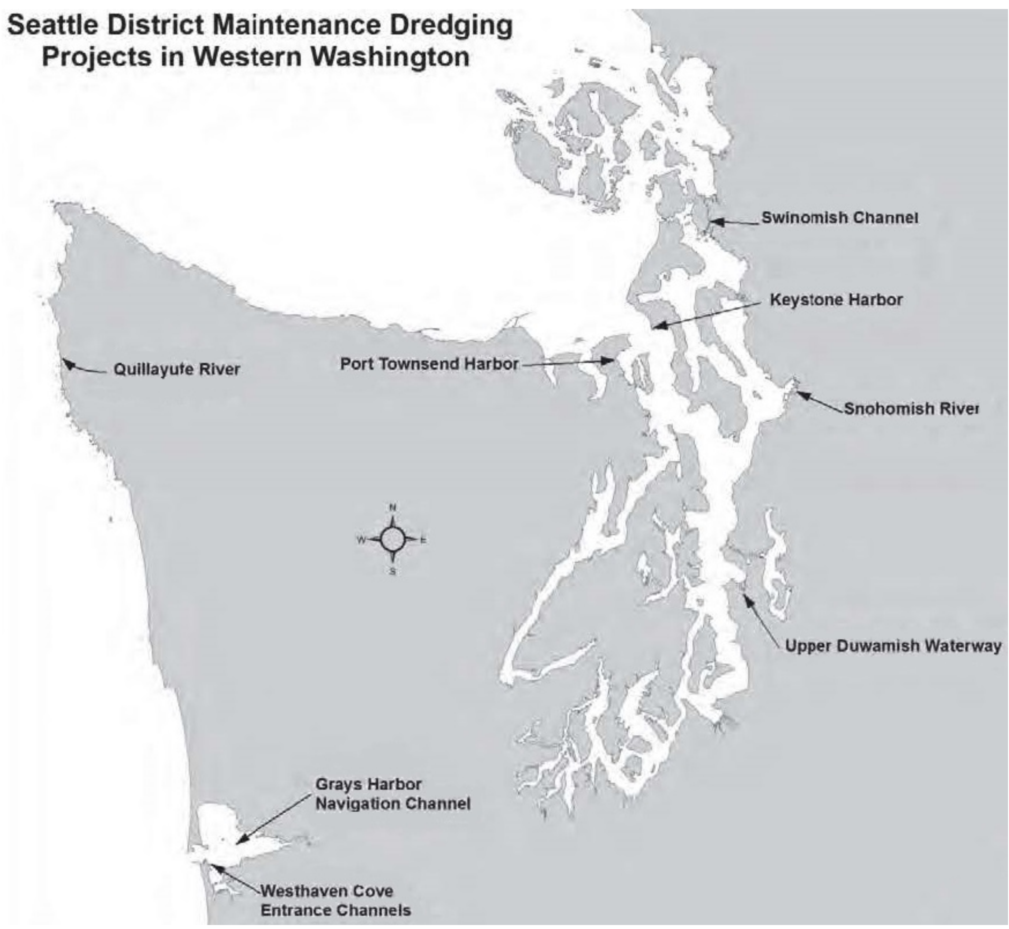

Figure 1. Western Washington State with the eight dredging sites indicated (Adapted from COE 2016a).

Hydrographic Surveys, Testing of Channel Sediments, and Removal of Navigation Hazards and Underwater Obstructions

The COE would operate small vessels equipped with side scan sonar to conduct hydrographic surveys to monitor the conditions of the channels, and to determine the quantity of material that may require removal to maintain the navigation channels. The COE would also conduct post-dredging hydrographic surveys of the channels to ensure that maintenance goals have been met.

The COE would conduct periodic testing of channel sediments according to the requirements and guidelines of the Dredged Material Management Program (DMMP) to determine the material's suitability for unconfined aquatic disposal in the marine environment. The COE, the US Environmental Protection Agency (EPA), and the Washington State Departments of Ecology and Natural Resources (WDOE and WDNR) administer the DMMP. Sediment testing would typically occur every six years for a given location, but intervals may vary based on historical findings (i.e. areas previously found to have unsuitable material will undergo testing prior to any dredge event). Only material that is deemed suitable for aquatic disposal under the DMMP protocols and standards would be dredged as a part of this maintenance dredging program. The removal of any material determined to be unsuitable is specifically excluded from this program, and would be subject to a separate consultation should that work be considered. Any trash, debris, woody material, large logs, or other items that are encountered during dredging, but cannot be placed at the established sediment disposal sites, would be separated from the sediments and hauled off site and disposed of appropriately.

Dredging Activities

Dredge technologies that would be employed as part of this program are: (1) mechanical, (2) hydraulic pipeline, and (3) hopper. Although some dredges are self-propelled, most mechanical and hydraulic pipeline dredges are un-propelled barges that are equipped with vertical steel pipes or I-beams called spuds (Figure 2). Some may use anchors. The spuds typically used for this work are about 19- to 24-inches in diameter. The barges are positioned by tug boat, then the spuds are pushed down into the substrate to hold the barge at its location. Some dredge barges can move short distances on their own. However, repositioning a barge typically requires tug assistance, particularly for long distances. Once repositioned, the spuds are again lowered to secure the barge.

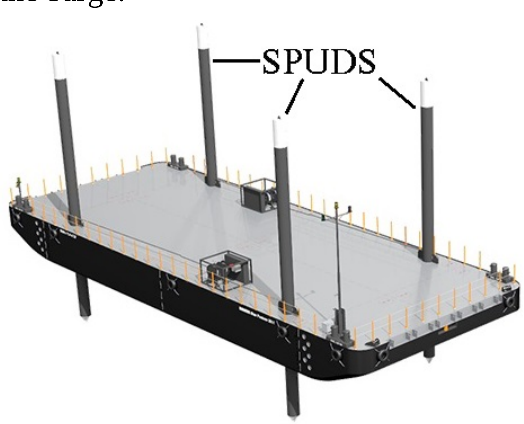

Figure 2. Un-propelled barge with four spuds.

Mechanical dredging typically involves a barge-mounted crane with clamshell bucket, but may also include the use of barge-mounted excavator or backhoe with a digging bucket at the end of an articulated arm. A crane dredge consists of a large construction crane with a steel bucket with two hinged jaws that is suspended by a winch cable under the crane boom. Typically, a sediment transport barge is positioned alongside the dredge barge during active dredging (Figure 3).

Figure 3. Barge-mounted crane dredge with clamshell bucket and a sediment transport barge tied alongside.

Gravity is the only downward force exerted on the bucket. The bucket is lowered to the bottom where it sinks into channel sediments and is then closed, taking a “bite” of sediment. The crane then raises the bucket and swings it over a sediment transport barge, where the bucket is dumped. When the transport barge is full, a tug takes it to the disposal site, which is discussed in more detail below. The crane can be used to execute other tasks such as loading and offloading equipment and supplies, as well as removal of obstructions and debris.

Barge-mounted excavators and backhoes may also be used for mechanical dredging and/or to loosen some substrates prior to other dredging methods. Both pieces of equipment consist of a cab with an articulated arm that has a scoop or clamshell bucket at its end. Excavators tend to be larger than backhoes, have rotatable cabs, and their arms may be driven by cables or hydraulics. Backhoes tend to be smaller, with hydraulically driven arms that can pivot about 90 degrees to one side or the other. The arm of an excavator or backhoe extends the bucket to the substrate. In the case of a clamshell, the bucket bites the substrate, whereas the scoop is pulled down and back to dig in. The bucket is then raised, moved to the transport barge, and dumped. Mechanical dredge barges can pivot and move short distances by setting the dredge bucket into the substrate, retrieving one or more spuds, then pulling against the bucket, after which the spuds are reset (Figure 4).

Figure 4. Excavator dredge with a hydraulic arm and scoop bucket on a spud barge.

A hydraulic pipeline dredge consists of a barge-mounted suction pipe with a centrifugal pump. The pipe is typically 8- to 36-inches in diameter, with a sediment loosening device attached to the intake end. The most common types of sediment loosening devices are cutter-heads, auger-heads, and water jets. The intake end of the pipe is lowered to the substrate to suck up loosened sediments that are discharged through a pipeline either to a barge or directly to the disposal site. Cutter-heads are preferred for hard material such as consolidated clays and silts, as well as compacted sands and gravels. They consist of a rotating metal basket, three to four times the diameter of the pipe, with numerous teeth and large openings. The basket's axis of rotation is in-line with the pipe, and it spins like a drill to break up the sediment (Figure 5). The loosened material is then sucked into the pipe.

Auger dredges are typically used to remove softer sediments. They consist of a shrouded Archimedean screw with its axis of rotation perpendicular to axis of the pipe, and oriented parallel to the substrate (Figure 5). The auger acts like a rotating hoe to loosen fine sediments that are then sucked into the pipe. The shroud helps contain sediments and reduces turbidity. Hydraulic water jets use concentrated high-speed streams of water to loosen unconsolidated sediments that are then drawn into the pipe.

Figure 5. Hydraulic pipeline dredges. A cutter-head is shown on the left, and an auger on the right.

Typically, hydraulic pipeline dredge barges are un-propelled. They must be positioned by tug, but they can pivot and move short distances using anchors and spuds that are mounted at the end of the barge opposite from the intake pipe. Once the barge is positioned, a spud is dropped, and a small tender vessel sets the anchors off the adjacent corners of the barge. Anchor winches pull against the anchor lines to cause the barge to pivot on the spud, and sweep the cutter-head across the dredge area. At the end of the sweep, the other spud is set, and the first spud is retrieved. The anchor line process is repeated, sweeping the cutter-head across the work area in the opposite direction. In this fashion, the dredge also moves forward. The tender vessel redeploys the anchors as needed. A variation on this theme is a barge with a "walking" spud. In this case, a single spud is located near the centerline of the barge, the anchor lines are selectively pulled in to pivot the barge around the spud.

Dredged material is drawn through the pipeline in the form of a slurry of water and sediment that can be discharged to a transport barge or other disposal locations, including upland or nearshore areas. The pipeline can be floated with attached flotation, or it may lie on the bottom. The distance the slurry can be pumped is determined by the sediment type and number of pumps between the dredge and the discharge location. Additional pumps are needed at intervals of about 1 mile to move the slurry greater distances. Using this system, dredged material can be placed at its final destination without re-handling the material. If material is placed upland, the slurry is typically discharged into a one or more settling basins to minimize turbidity in receiving waters. Settling basins are typically constructed with a bulldozer or excavator create perimeter berms of native material where the dredged material will be deposited. The solid fraction settles out of the slurry and the water infiltrates into the ground and/or filters through the berms surrounding the settling basin. In situations where environmental risk is low, the dredger may directly discharge into the nearshore zone.

A hopper dredge is a large, self-propelled, ocean-going vessel that is equipped with powerful vacuum pumps that are attached to long pipes (drag arms) that are suspended over both sides of the ship. Shrouded cutter heads are typically installed on the suction ends of the drag arms, which are plumbed to discharge into a series of large, built-in storage tanks located in the central portion of the ship (hoppers) (Figure 6).

Figure 6. A drawing of a hopper dredge with its drag arms deployed is shown on the left. A retracted drag arm is shown on the right.

The hoppers have discharge hatches in the underside of the ship. Hopper dredges are typically deep draft vessel that cannot operate in shallow waters, but they are ideal for situations where rough conditions require a large vessel and/or the capability to operate in the ocean is needed. In the Seattle District, hopper dredges are used only in outer Grays Harbor where the sea state mandates a vessel with ocean going capabilities, and is typically done with COE-owned and operated hopper dredges, but the COE may occasionally contract with a private hopper dredge operator.

When the hopper dredge is in position to dredge, the drag arms are lowered to the substrate and the suction and cutter heads are engaged. The vessel moves forward in straight lines, dragging the suction heads along the bottom. Similar to hydraulic pipeline dredges, a slurry of sediment and water is drawn through the drag arms. The slurry is discharged into the hoppers. The dredge has sufficient vacuum power to pick up debris such as bottles and garbage. Much of the debris is mechanically removed from the incoming stream and is not returned to the aquatic environment. The sediments settle to the bottom of the hoppers, and water is decanted off the top to be discharged into the surrounding water. At the end of the run, the heads are lifted slightly with pumps still running briefly to clear the slurry out of the pipes before the pumps are secured. The drag arms are lifted and the ship moves to the starting point of the next run, where the drag arms are redeployed, and the process is repeated until the area is finished or the hopper is filled. When the hopper is full, the drag arms are lifted as described above, and the ship proceeds to a designated in-water disposal site. At the disposal site, the hatches in the bottom of the hoppers are opened, and the dredged material drops through the bottom of the ship. Some hopper dredges have auxiliary equipment to pump dredged material from the hopper via a pipeline.

Disposal of Dredged Materials

Disposal methods include a variety of alternatives. Most of the eight dredging locations considered in this consultation include one or more disposal alternatives in which all or part of the dredging material would be disposed of at designated multi-user open-water disposal sites (open-water disposal sites) that are managed under the (DMMP) (Figure 7). The effects of sediment disposal at the DMMP open-water disposal sites have already been considered in the programmatic formal consultation for their continued use through 2040 (NMFS 2015a). Therefore, the use of DMMP open-water disposal sites for disposal of sediments that have been removed as part of this action are not considered a part of the proposed action. Many of the project sites also include disposal alternatives in which dredged sediments would be placed in upland or nearshore sites for beneficial uses that include beach nourishment, creation of shallow water habitat, maintenance of longshore drift cells, shoreline stabilization, erosion protection, containment of contaminated substrate, etc.

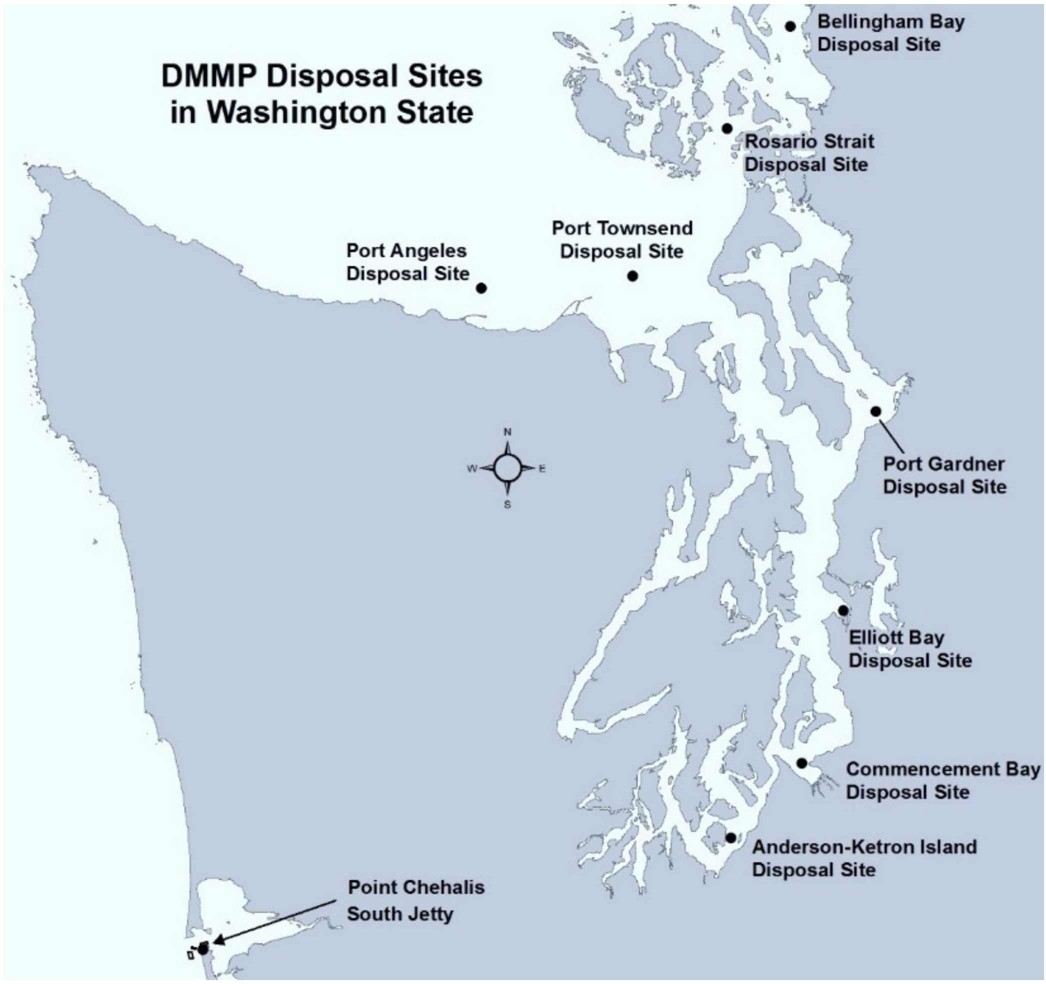

Figure 7. Multi-user open-water disposal sites in Washington State managed under the Dredged Material Management Program (DMMP).

For upland disposal, the sediments may be deposited directly or trucked to the final location. In the case of sediment transport barges, the barge would be positioned close to shore or tied to a pier. The sediments would then be offloaded by crane; directly to the final destination when it is close to shore, or to a dewatering site where the material would be temporarily stored until it is trucked to its final destination. In the case of hydraulic pump disposal pipelines, the material may again be deposited directly to the final disposal location or to an intermediate dewatering site, where after dewatering, the material would be loaded onto trucks for transportation to the final disposal site.

The COE BA defines “nearshore” as shoreline areas at supratidal elevations. This zone is the area between the splash zone above Mean Higher High Water (MHHW) that is inundated only during extreme tides, and the subtidal zone to a depth of about 100 feet (30 m) below Mean Lower Low Water (MLLW). Nearshore disposal would include the methods described above, including trucking sediments to a nearshore disposal site. Sediments placed in the splash zone and upper intertidal areas may be also be spread with dozers or other earth-moving equipment after initial deposition. Additionally, bottom-drop barges and hopper dredges may discharge sediments into this zone though the hatches in the hull, with the draft of the vessel determining the minimum practicable water depth for application.

Open-water disposal would be accomplished by hopper dredges and transport barges equipped with disposal hatches. As mentioned above, hopper dredges are self-propelled. They would proceed to the discharge point near the center of a designated open-water disposal site, open the discharge hatches, and allow the dredge spoils to sink to the seafloor. Transport barges would be similarly operated with the exception that they would require a tug to move between the dredge area and the disposal site. The effects of the use of the designated open-water disposal sites has been considered in separate consultations (NMFS 2010a; NMFS 2015a) and is not considered part of the proposed action. The use of open-water disposal is described in this Opinion only for continuity.

Individual Project Sites

The general dredging and disposal methods described above would be used in some combination at each of the individual project sites as describe below.

The Grays Harbor Navigation Channel is located on the southwest coast of Washington, about 45 miles north of the mouth of the Columbia River. The channel was first authorized in 1896 and has gone through numerous modifications between 1935 & 1986, and was deepened in 2016. The maintained navigation channel is 23.5 miles long. It begins outside of the harbor's entrance, extends into the lower mainstem of the Chehalis River, and covers an area of about 940 acres. The channel is divided into 10 reaches with two turning basins (Figures 1 and 8).

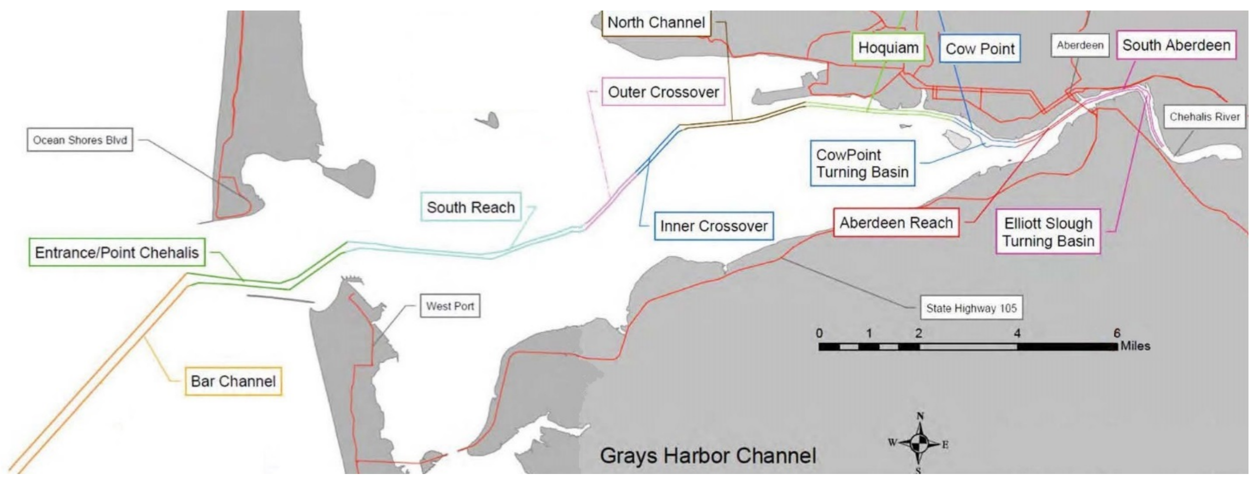

Figure 8. Grays Harbor Channel Reaches and Turning Basins (Adapted from COE 2016a).

The dredge and disposal methods and the work windows depends on the reach. In general, hopper dredging would be done in the outer 3 reaches, a combination of hopper and clamshell dredging would be done in the 4th (Outer Crossover), and clamshell dredging would be done in the inner harbor reaches (Table 1). The maximum annual volume that would be dredged is about 4,400,000 cubic yards (CY), with an expected average of about 3,700,000 CY. In the 4 western-most channel segments, about 1 month of dredging would be done annually between April 1st and June 30th. The COE hopper dredges Essaysons and Yaquina have annual maintenance dredging assignments for the outer harbor segments in Grays Harbor. A contractor hopper dredge with pump-off capabilities is also employed when direct upland disposal is required. Contracted mechanical dredges would be used in the inner harbor reaches and turning basins. Typically, about 5 to 6 months of dredging would be required annually, between July 16th and February 14th, to complete this work.

Table 1. Details of Grays Harbor Navigation Channel and the dredging schedules for the individual reaches and turning Basins.

Channel Reach	Channel Dimension	Dredge Type	Sediment Type	Volume Periodicity	Work Window	Disposal Area
Bar Channel	900 ft wide 46 ft deep	Hopper	Sand	300,000 CY Annual	Apr 1 – May 31	South Beach or South Jetty
Entrance Point	600 - 900 ft wide 40 - 46 ft deep	Hopper	Sand	900,000 CY Annual	Apr 1 – May 31	South Jetty, Half Moon Bay, or Point Chehalis
South Reach	350 - 450 ft wide 38 ft deep	Hopper	Sand	300,000 CY Annual	Apr 1 – June 30	Point Chehalis or Half Moon Bay
Outer Crossover	350 ft wide 38 ft deep	Hopper or Clamshell	Silty Sand	300,000 CY Annual	Hopper: Apr 1 – May 31 Clamshell: Aug 1 – Feb 14	Point Chehalis
Inner Crossover	350 - 450 ft wide 38 ft deep	Clamshell	Silty Sand	300,000 CY Annual	Aug 1 – Feb 14	Point Chehalis
North Channel	350 ft wide 38 ft deep	Clamshell	Silty Sand	300,000 CY Annual	Aug 1 – Feb 14	Point Chehalis
Hoquiam	350 ft wide 38 ft deep	Clamshell	Sandy Silt	500,000 CY Annual	Jul 16 – Feb 14	South Jetty or Point Chehalis
Cow Point Turning Basin	350 - 950 ft wide 38 ft deep	Clamshell	Sandy Silt	300,000 CY Annual	Jul 16 – Feb 14	South Jetty or Point Chehalis
Cow Point	350 - 550 ft wide 38 ft deep	Clamshell	Sandy Silt	800,000 CY Annual	Jul 16 – Feb 14	South Jetty or Point Chehalis
Aberdeen	200 – 300 ft wide 32 ft deep	Clamshell	Silt & Sand	200,000 CY Semi-Decadal	Jul 16 – Feb 14	South Jetty or Point Chehalis
Elliott Slough Turning Basin	350 - 550 ft wide 32 ft deep	Clamshell	Silt & Sand	60,000 CY Biennial	Jul 16 – Feb 14	South Jetty or Point Chehalis
South Aberdeen	200 – 300 ft wide 32 ft deep	Clamshell	Silt & Sand	150,000 CY Semi-Decadal	Jul 16 – Feb 14	South Jetty or Point Chehalis

Sediment disposal for Grays Harbor maintenance dredging would be done at two open-water disposal sites (Point Chehalis and South Jetty Open-Water Placement sites), two nearshore subtidal disposal sites (South Beach and Half Moon Bay), and one upland disposal site (Point Chehalis Revetment Extension Mitigation site) (Figure 9). The Point Chehalis and South Jetty open-water disposal sites are located directly adjacent to the navigation channel, and are managed by the Washington State Department of Natural Resources (WDNR).

Materials dredged from the 3 outer harbor reaches are marine sands deposited by tidal action and silty sand to sandy silt that has been redistributed within the estuary by wind and wave action. Some of that material would be disposed of at the South Beach nearshore nourishment site, and at Half Moon Bay (which includes both subtidal and direct beach nourishment), and at the Point Chehalis Revetment Extension Mitigation site. The remaining material would be disposed of in one of the open-water disposal sites. The South Beach nearshore site is located in the Pacific Ocean about 1 mile south of South Jetty and about 2 miles offshore of the beach in that area. The Half Moon Bay nearshore site is immediately north of the eastern third of South Jetty, extending to the shore in Half Moon Bay where it joins with the direct beach nourishment site. The Point Chehalis Revetment Extension Mitigation site is located above the splash zone along the northeast corner of Half Moon Bay (Figure 9). Dredged material placed in the South Beach and Half Moon Bay beneficial use disposal sites would typically be dredged and transported via hopper dredge, but could on occasion be dredged and transported via bottom dump barges positioned by tugs. Dredged material placed in the Half Moon Bay direct beach nourishment site and at the Point Chehalis Revetment Extension Mitigation site would typically be dredged and transported via a specially equipped, contracted hopper dredge with a pipeline disposal system. However, crane-offloaded barges may also be used.

Dredged material placed in the South Beach and Half Moon Bay beneficial use disposal sites would enter the littoral transport system and help maintain the local beaches. Dredged material placed in the upland mitigation site is to maintain a stable beach profile and to ensure that the armor stone of the revetment extension is not exposed to wave action. Materials dredged from the remaining harbor reaches consists mostly of terrigenous sands and silts that would be deposited in the Point Chehalis and South Jetty open-water placement sites via bottom-dumped transport barges.

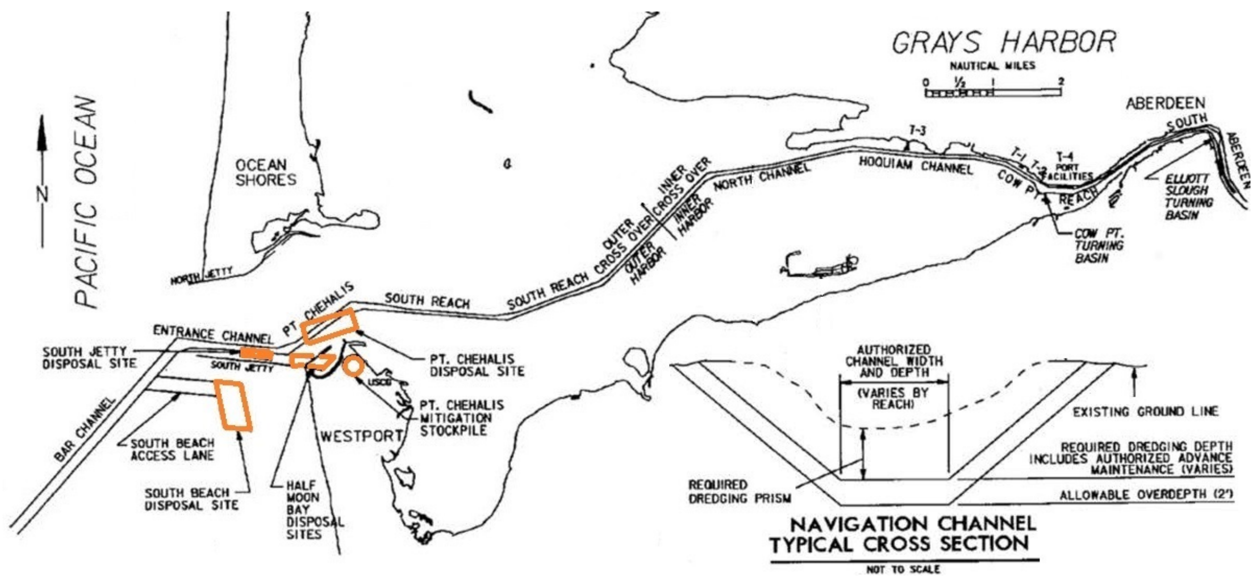

Figure 9. Grays Harbor showing the sediment disposal sites (orange polygons and circles) relative to the channel reaches and turning basins. The inset shows a typical channel cross section (Adapted from COE 2016a).

The Westhaven Cove Small Boat Basin is located along the east shore of Westport, south of the Grays Harbor entrance channel (Figures 1 and 10). The Westhaven Cove small boat basin first became operational in 1952, with a second channel added in 1979. The two channels are 100 to 200 feet wide, with an authorized depth of 14 feet below mean lower low water (-14 feet MLLW). Including the turning basin, the dredging area covers 9 acres. Up to 75,000 CY of sediment would be removed from the two channels and the turning basin very 10 years. Clamshell or hydraulic dredging would be done over 14 to 21 days between July 16 and January 31. The dredged material would be disposed of via open-water disposal at the Point Chehalis or the South Jetty dispersive open-water disposal sites (Figure 9).

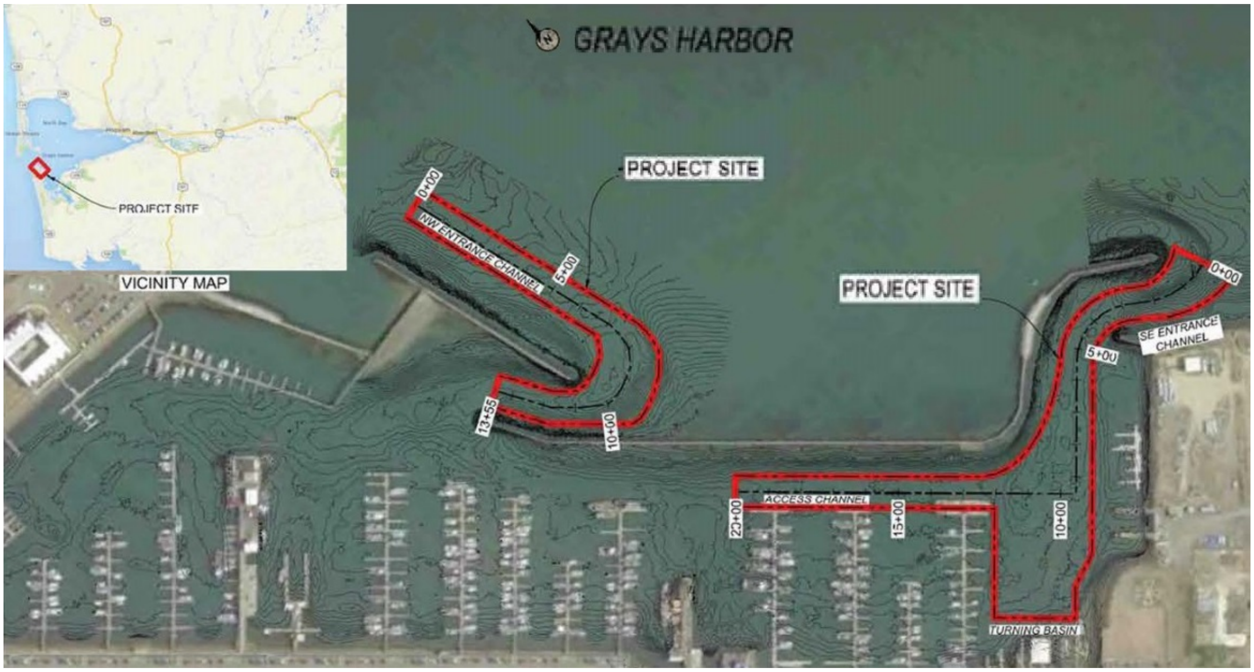

Figure 10. Westhaven Cove Small Boat Basin with the two navigation channels and turning basin outlined in red (Adapted from COE 2016a).

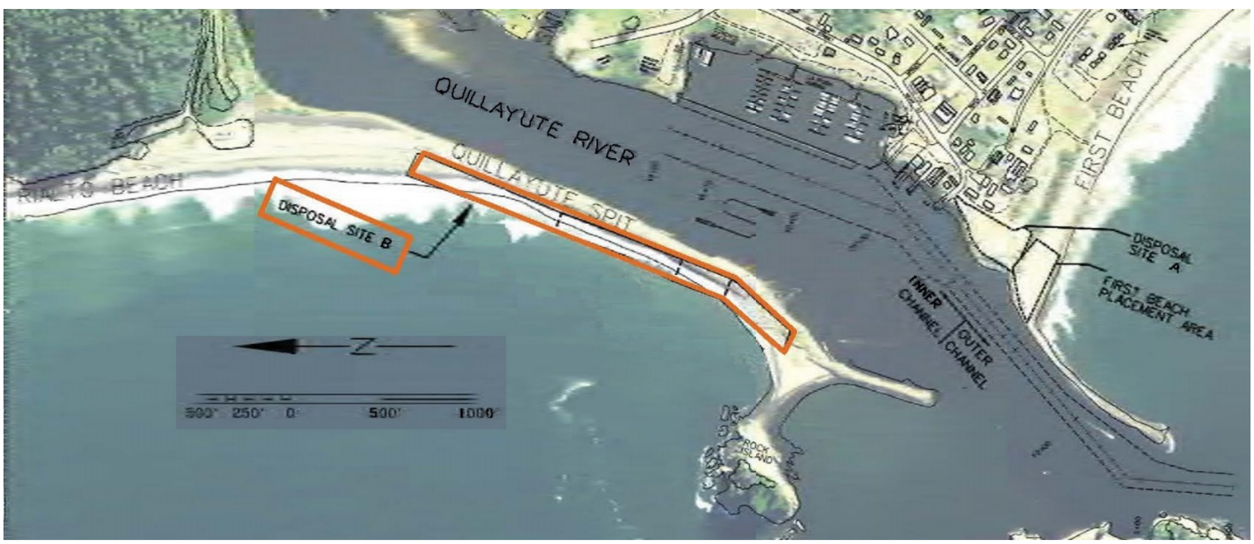

Figure 11. Quillayute River Navigation Channel (Adapted from COE 2016a).

The <u>Quillayute River Navigation Channel</u> is located at La Push, on the Northwest coast of the Olympic Peninsula (Figures 1 and 11). It was constructed in 1932, and modified in 1945 and 1954. It now consists of a 3,500-foot long, 75- to 275-foot wide navigation channel, and a 1,070-foot by 313-foot boat basin that have an authorized depth of -10 feet MLLW. Every 2 years, 60 days of hydraulic pipeline dredging would be done between September 1 and February 28 to remove up to 100,000 CY of sediment. The dredged material would be disposed of via hydraulic pipeline to the Quillayute Spit (Area B) and/or to an area inland of the jetty for disposition on First Beach (Area A), or for upland beneficial use.

The Port Townsend Harbor is located near the east end of the Strait of Juan de Fuca. The entrance channel and a 14-acre mooring basin were first authorized in 1958. In 1964, the breakwater was extended, and a 4-acre commercial vessel basin was added at the northwest end of the harbor (Figures 1 and 12). The dredging program would maintain the 1,916-foot long, 40-foot wide channel, the 2,100 square-foot USCG mooring slip, and the 14-acre mooring basin. Every 8 to 10 years, about 45 days of clamshell dredging would be done between July 16 and February 15 to remove up to 50,000 CY of sediment. The dredged material would be disposed of via bottom dump barge to the DMMP-managed Port Townsend open-water dispersive disposal site located in the Strait of Juan de Fuca (Figure 7).

Figure 12. Port Townsend Harbor with the navigation channel and US Coast Guard (USCG) slip outlined in red. The southeastern section is the 14-acre mooring basin for the public marina. The northwestern section is a 4-acre commercial mooring basin that includes the USCG pier.

The Keystone Harbor Federal Navigation Channel consists of a 6-acre harbor with a 1,800-foot long, 200-foot wide entrance channel located along the central western shore of Whidbey Island (Figures 1 and 13). The site was originally constructed in 1945, widened in 1971, and deepened in 1993. Clamshell or hydraulic dredging would be done every 5 years to remove up to 75,000 CY of accumulated sediments from the harbor and channel. Up to 120 days of work would be done between July 16 and February 15 per event. The dredged material would be deposited on the designated beach disposal site, east of the breakwater, to maintain sediment transport. When mechanical dredging is used, sediments would be transported by barge, and deposited by bucket crane. During hydraulic dredging, sediments would be directly deposited by pipe. After sediment deposition, heavy equipment, such as front end loaders would be used to spread the sediments evenly over the disposal site.

Figure 13. Keystone Harbor and beach disposal site (Adapted from COE 2016a).

The Swinomish Federal Navigation Channel is an 11-mile long, 100- to 125-foot wide, human-made canal near La Conner, Washington (Figures 1 and 14). It was authorized by Congress in 1892, and completed in 1937, to connect Padilla Bay with Skagit Bay, and has been maintained since. Clamshell dredging would be done every 2 to 7 years to remove up to 230,000 CY of accumulated sediments from the channel. Up to 150 days of work would be done between July 16 and February 15 per event. The dredged material would be transported by barge to an open-water disposal site such as the Rosario Strait dispersive site or the Port Gardner disposal site (Figure 7).

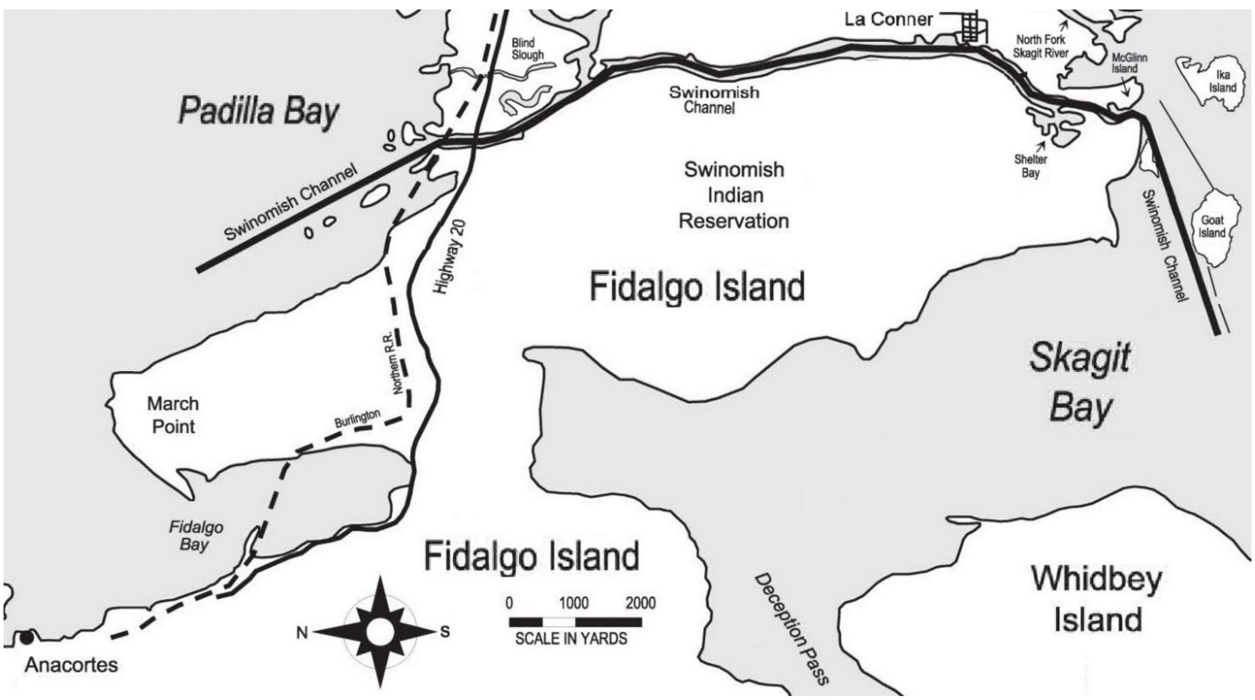

Figure 14. Swinomish Federal Navigation Channel (Adapted from COE 2016a).

The Everett Harbor and Snohomish River Navigation Channel is located in Possession Sound, at the eastern edge of the Puget Sound. It was first authorized in 1910 and has been modified more than a dozen times since. The maintained navigation channel is about 6.6 miles long. It begins between the Everett Naval Station and the south end of Jetty Island, proceeds north between Jetty Island and the mainland, and follows the lower Snohomish River around the north end of the City of Everett. From the channel entrance, the first mile is 150 to 425 feet wide, with a depth of -15 feet MLLW. The lower settling basin is 1,200-foot long, 700-foot wide, and -20 feet MLLW. The remaining 6.3 miles of channel is about 150 feet wide, and a depth of -8 feet MLLW, with the exception of the 1,740-foot long upper settling basin, which has a depth of -40 feet MLLW. The upper settling basin is near the upstream end of the channel, just east of the I-5 highway (Figures 1 and 15).

Figure 15. Everett Harbor and Snohomish River Navigation Channel. The channel and settling basins are outlined in red (Based on Figures 10 and 20 in COE 2016a).

Annual dredging typically alternates between the upstream settling basin and channel, and the downstream settling basin and channel, with up to 700,000 CY of accumulated sediments removed by 60 to 90 days of clamshell or hydraulic pipeline dredging done between October 16 and February 14. However, situations may occur where up to 120 days of work would be required to remove up to 1,200,000 CY of sediments from the both settling basins and the channel over a single dredge cycle. That work would also be done between October 16 and February 14.

The disposal sites include the DMMP Port Gardner open-water disposal site (Figure 7), as well as three beneficial use disposal sites: Jetty Island, Riverside, and Site "O" (Figure 15). Jetty Island began as a wood pile jetty that was installed in 1901 to protect the Port of Everett from the open waters of Port Gardner. Since about 1903, the Corps has disposed dredged material from the navigation channel along the west side of the wood/rock jetty. All but the southern end of the jetty is now buried, and the size of the island is now maintained by a balance between periodic disposal of dredged sediments and natural erosion. Typically, up to 40,000 CY of sediment is disposed at Jetty Island every-other year, but the frequency could vary. Over the next 25 years, about 1,250,000 CY of dredged sediments would be disposed at Jetty Island. Disposal at the site is done via a hydraulic pipeline that is placed across the island, along a route that limits impacts on vegetation, and avoids a high salt marsh located at the north end of the island. Sediments are discharged at the top of the existing beach at elevations of +1 to +15 feet MLLW, to form a 10:1 slope that ties into the grade of the adjacent beach. Materials are allowed to naturally disperse in the nearshore zone between the shoreline and out to -30 feet MLLW.

The Riverside Disposal Site is an 8-acre area in the southern end of the Riverside Business Park, located on the left bank of the Snohomish River at about river mile 5 (Figure 15). Hydraulically dredged sediments would be directly disposed of at the site through a pipeline that would extend from a dredge in upstream settling basin and the adjacent channel, and remain in place about 3 to 4 weeks. Before the start of a dredge cycle, a small work boat would tow a plastic discharge pipeline from the dredge to the riverbank during high tide. From there, heavy equipment would pull the pipe up and over the site’s sand containment berm, following a path selected to minimize impacts to intertidal salt marsh and riparian vegetation. Following discharge and dewatering of sediments, the dredged material is collected and moved by truck for use as fill at the Riverside Business Park or other regional sites. Typically, up to 40,000 CY of sediment would be disposed at the site every-other year, but the frequency could vary. Over the next 25 years, about 350,000 CY of dredged sediments would be disposed of at the site.

Site “O” is a 9-acre area in the former Kimberly Clark log yard, located on the left bank of the Snohomish River at about river mile 4 (Figure 15). Hydraulically dredged sediments from the upstream settling basin and adjacent channel would be directly discharged and disposed of at this site in a manner nearly identical as that described above for the Riverside site. Typically, up to 150,000 CY of sediment would be disposed at the site every-other year, but the frequency could vary. Over the next 25 years, about 650,000 CY of dredged sediments would be disposed of at the site.

The Upper Duwamish Waterway is located upstream of the Port of Seattle at the south end of Elliott Bay. The Seattle Harbor Federal Navigation project was first authorized in 1919 and has been modified many times since. The Duwamish Waterway navigation channel is 5.3 miles long. However, the section of channel that would be maintained under this program is limited to a 2,800-foot long 150-foot wide section of channel, and a 500-foot long 250-foot wide turning basin, both with depths of -15 feet MLLW, that is located west of the south end of Boeing Field (Figures 1 and 16). Every 1 to 3 years, about 45 days of clamshell dredging would be done between October 1 and February 15 to remove up to 250,000 CY of sediment. Under this program, the dredged material would be disposed of via bottom dump barge to the DMMP-managed Elliott Bay open-water non-dispersive disposal site (Figure 7).

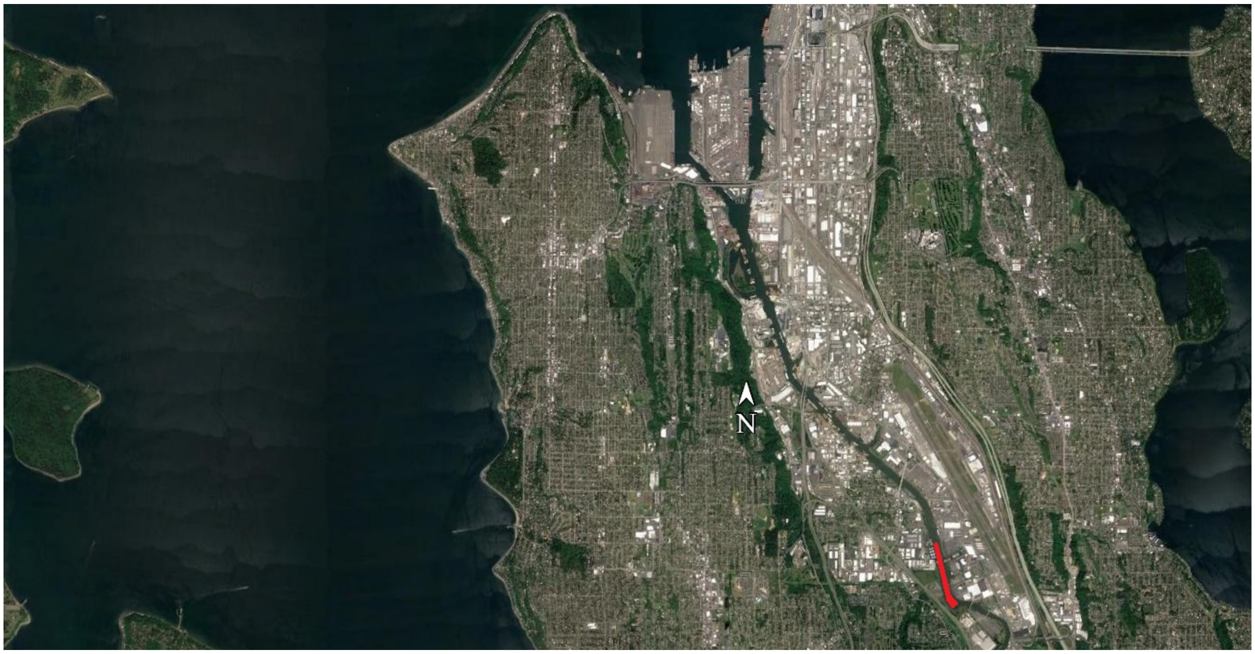

Figure 16. The Upper Duwamish Waterway. The section of channel and turning basin that would be dredged are indicated in red (Based on Figures 11 in COE 2016a).

1.4 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). As described in subsections 2.4 through 2.6, at all eight project sites, elevated in-water noise would be the project-related stressor with the greatest range of direct effects. All other project-related effects, including indirect effects would be undetectable beyond the range of acoustic effects. Therefore, for the purposes of this consultation, at each of the eight channels considered here, the action area for NMFS trust resources consists of the insonified area around project-related vessels, out to the range where the onset of minor detectable effects in marine mammals could be expected to occur. Specifically, for Grays Harbor and Westhaven Cove, the action area is limited to Grays Harbor and the marine waters within about 3.4 miles around its entrance. For the other six other channels, the action area is limited to the individual channels and the adjacent waters within about 1.4 miles of those channels.

The action area for the combination of dredging sites overlaps with the geographic ranges and boundaries of the ESA-listed species and designated CH identified below in Table 2. Detailed information about the biology, habitat, and conservation status for those species can be found in the recovery plans and other sources at: http://www.nmfs.noaa.gov/pr/species/fish/, http://www.nmfs.noaa.gov/pr/species/mammals/, and http://www.nmfs.noaa.gov/pr/species/turtles/.

The action area also includes areas that have been designated, under the MSA, as EFH for Pacific Coast salmon, Pacific Coast Groundfish, and Coastal Pelagic Species.

Table 2. ESA-listed marine species and critical habitat that may be affected

ESA-listed marine species and critical habitat likely to be adversely affected				
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)
Hood Canal Summer-run chum salmon (*O. keta*)	Threatened	NLAA	LAA	06/28/05 (70 FR 37160) / 09/02/05 (70 FR 52630)
steelhead (*O. mykiss*) Puget Sound	Threatened	LAA	LAA	05/11/07 (72 FR 26722) / 02/24/16 (81 FR 9252)
bocaccio (*Sebastes paucispinis*) Puget Sound/Georgia Basin	Endangered	NLAA	LAA	04/28/10 (75 FR 22276) / 11/13/14 (79 FR 68041)
eulachon (*Thaleichthys pacificus*) southern	Threatened	LAA	N/A	03/18/10 (75 FR 13012) / 10/20/11 (76 FR 65324)
green sturgeon (*Acipenser medirostris*) southern	Threatened	LAA	LAA	04/07/06 (71 FR 17757) / 10/09/09 (74 FR 52300)
ESA-listed marine species and critical habitat not likely to be adversely affected				
Species	**Status**	**Species**	**Critical Habitat**	**Listed / CH Designated**
Lower Columbia River Chinook salmon (*O. tshawytscha*)	Threatened	NLAA	N/A	06/28/05 (70 FR 37160) / 09/02/05 (70 FR 52630)
Upper Willamette River Chinook salmon (*O. tshawytscha*)	Threatened	NLAA	N/A	06/28/05 (70 FR 37160) / 09/02/05 (70 FR 52630)
Columbia River chum salmon (*O. keta*)	Threatened	NLAA	N/A	06/28/05 (70 FR 37160) / 09/02/05 (70 FR 52630)
yelloweye rockfish (*S. ruberrimus*) PS/GB	Threatened	NLAA	NLAA	04/28/10 (75 FR 22276) / 11/13/14 (79 FR 68041)
blue whales (*Balaenoptera musculus*)	Endangered	NLAA	N/A	12/02/1970 (35 FR 18319) / N/A
fin whale *(B. physalus)*	Endangered	NLAA	N/A	12/02/1970 (35 FR 18319) / N/A
Central America humpback whales (*Megaptera novaeanglia*)	Endangered	NLAA	N/A	09/08/16 (81 FR 62259) / N/A
Mexico humpback whales (*Megaptera novaeanglia*)	Threatened	NLAA	N/A	09/08/16 (81 FR 62259) / N/A
killer whales (*Orcinus orca*) southern resident	Endangered	NLAA	NLAA	11/18/05 (70 FR 57565) / 11/29/06 (71 FR 69054)
sei whales (*B. borealis*)	Endangered	NLAA	N/A	12/02/1970 (35 FR 18319) / N/A
sperm whales (*Physeter macrocephalus*)	Endangered	NLAA	N/A	12/02/1970 (35 FR 18319) / N/A
green sea turtle (*Chelonia mydas*) East Pacific	Threatened	NLAA	N/A	04/06/16 (81 FR 20057) / 09/02/1998 (63 FR 46693)
leatherback sea turtles (*Dermochelys coriacea*)	Endangered	NLAA	NLAA	06/02/1970 (35 FR 8491) / 01/26/12 (77 FR 4170)
loggerhead sea turtle (*Caretta caretta*) North Pacific Ocean	Endangered	NLAA	N/A	09/22/11 (76 FR 58868) / 07/10/14 (79 FR 39856)
olive Ridley sea turtles (*Lepidochelys olivacea*)	Threatened	NLAA	N/A	07/28/1978 (43 FR 32800) / N/A

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

2. 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 provides an opinion stating how the agency's actions would affect listed species and their critical habitat. 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.

As described above in section 1.2, the COE determined the proposed action is not likely to adversely affect all of the species and critical habitat identified in Table 2. However, NMFS has concluded that the proposed action is likely to adversely affect PS Chinook salmon, PS steelhead, southern eulachon, and southern green sturgeon, and designated critical habitat for PS Chinook salmon, HCSR chum salmon, PS steelhead, PS/GB bocaccio, and southern green sturgeon and that formal consultation was required. Our concurrence with the COE's "not likely to adversely affect" determinations for the remaining species and critical habitat is documented in the "Not Likely to Adversely Affect" Determinations section (2.11).

2.1 Analytical Approach

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

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

Past critical habitat designations have used the terms primary constituent element (PCE) or essential feature (EF) to identify important habitat qualities. However, the new critical habitat regulations (81 FR 7414; February 11, 2016) replace those terms with physical or biological features (PBF). This shift in terminology does not change the approach used in conducting our analysis, whether the original designation identified PCE, EF, or PBF. For simplicity, we universally apply the term PBF in this Opinion for all critical habitat, regardless of the term used in the specific critical habitat designation.

We use the following approach to determine whether a proposed action is likely to jeopardize listed species or to cause the destruction or adverse modification of designated critical habitat:

- Identify the range-wide status of the species and critical habitat expected to be adversely affected by the proposed action.
- Describe the environmental baseline in the action area.
- Analyze the effects of the proposed action on both species and their habitat using an "exposure-response-risk" approach.
- Describe any cumulative effects in the action area.
- Integrate and synthesize the above factors by: (1) Reviewing the status of the species and critical habitat; and (2) adding the effects of the action, the environmental baseline, and cumulative effects to assess the risk that the proposed action poses to species and critical habitat.
- Reach a conclusion about whether species are jeopardized or critical habitat is adversely modified.
- If necessary, suggest a reasonable and prudent alternative (RPA) to the proposed action.

2.2 Range-wide Status of the Species and Critical Habitat

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

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

During the last century, average regional air temperatures in the Pacific Northwest increased by 1-1.4°F as an annual average, and up to 2°F in some seasons (based on average linear increase per decade; Abatzoglou *et al*. 2014; Kunkel *et al*. 2013). 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, 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; Mote *et al*. 2014). Earlier snowmelt will cause lower stream flows in late spring, summer, and fall, and water temperatures will be warmer (ISAB 2007; Mote *et al*. 2014). Models consistently predict increases in the frequency of severe winter precipitation events (i.e., 20-year and 50-year events), in the western United States (Dominguez *et al*. 2012). The largest increases in winter flood frequency and magnitude are predicted in mixed rain-snow watersheds (Mote *et al*. 2014).

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 3.5-5.3°C increases in Columbia Basin streams and a peak temperature of 26°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 foodwebs (Crozier *et al*. 2011; Tillmann and Siemann 2011; Winder and Schindler 2004). Higher stream temperatures will also cause decreases in dissolved oxygen and may also cause earlier onset of stratification and reduced mixing between layers in lakes and reservoirs, which can also result in reduced oxygen (Meyer *et al*. 1999; Raymondi *et al*. 2013; Winder and Schindler 2004). Higher temperatures are likely to cause several species to become more susceptible to parasites, disease, and higher predation rates (Crozier *et al*. 2008; Raymondi *et al*. 2013; Wainwright & Weitkamp 2013).

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

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

Moreover, as atmospheric carbon emissions increase, increasing levels of carbon are absorbed by the oceans, changing the pH of the water. A 38% to 109% increase in acidity is projected by the end of this century in all but the most stringent CO2 mitigation scenarios, and is essentially irreversible over a time scale of centuries (IPCC 2014). Regional factors appear to be amplifying acidification in Northwest ocean waters, which is occurring earlier and more acutely than in other regions and is already impacting important local marine species (Barton *et al*. 2012; Feely *et al*. 2012). Acidification also affects sensitive estuary habitats, where organic matter and nutrient inputs further reduce pH and produce conditions that are more corrosive than those in offshore waters (Feely *et al*. 2012; Sunda and Cai 2012).

Global sea levels are expected to continue rising throughout this century, reaching likely predicted increases of 10-32 inches by 2081-2100 (IPCC 2014). These changes will likely result in increased erosion and more frequent and severe coastal flooding, and shifts in the composition of nearshore habitats (Reeder *et al*. 2013; Tillmann and Siemann 2011). Estuarine-dependent salmonids such as chum and Chinook salmon are predicted to be impacted by significant reductions in rearing habitat in some Pacific Northwest coastal areas (Glick *et al*. 2007). Historically, warm periods in the coastal Pacific Ocean have coincided with relatively low abundances of salmon and steelhead, while cooler ocean periods have coincided with relatively high abundances, and therefore these species are predicted to fare poorly in warming ocean conditions (Scheuerell and Williams 2005; Zabel *et al*. 2006). This is supported by the recent observation that anomalously warm sea surface temperatures off the coast of Washington from 2013 to 2016 resulted in poor coho and Chinook salmon body condition for juveniles caught in those waters (NWFSC 2015). Changes to estuarine and coastal conditions, as well as the timing of seasonal shifts in these habitats, have the potential to impact a wide range of listed aquatic species (Reeder *et al*. 2013; Tillmann and Siemann 2011).

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

2.2.1 Puget Sound (PS) Chinook Salmon

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

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

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

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

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

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

The summaries that follow describe the status of the ESA-listed species, and their designated critical habitats, that occur within the 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.

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 2006a). The recovery plan adopts ESU and population level viability criteria recommended by the Puget Sound Technical Recovery Team (PSTRT) (Ruckleshaus *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 (Table 3) achieve viability, depending on the historical biological characteristics and acceptable risk levels for populations within each region;
- At least one population from each major genetic and life history group historically present within each of the five biogeographical regions is viable;

- Tributaries to Puget Sound not identified as primary freshwater habitat for any of the 22 identified populations are functioning in a manner that is sufficient to support an ESU-wide recovery scenario; Production of Chinook salmon from tributaries to Puget Sound not identified as primary freshwater habitat for any of the 22 identified populations occurs in a manner consistent with ESU recovery; and
- Populations that do not meet all the Viable Salmon Population (VSP) parameters are sustained to provide ecological functions and preserve options for ESU recovery.

<u>Spatial Structure and Diversity:</u> 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 (Table 3).

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).

<u>Abundance and Productivity:</u> 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 TRT 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).

<u>Limiting Factors:</u> Factors limiting recovery for PS Chinook salmon include:

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

Table 3. Extant PS Chinook salmon populations in each biogeographic region (Ruckleshaus 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

PS Chinook Salmon within the Action Area: The wide spatial and temporal distribution of COE maintenance dredging work in the Puget Sound suggest that adults and juveniles from 18 to 20 of the extant PS Chinook salmon MPGs may be exposed to program-related dredging activities. The natal streams of the Elwha MPG and the Dungeness MPG are west (oceanward) of the Puget Sound dredging sites, and the migration routes of the juveniles and adults of those MPGs are unlikely to include any of dredging sites considered in the Opinion. Therefore, individuals from those MPGs are unlikely to be exposed. Depending on the routes taken by emerging juveniles and returning adults of the North Fork Nooksack MPG and the South Fork Nooksack MPG, some individuals from those MPGs may be exposed to dredging activities, but most individuals are expected to follow routes to the north that would keep them away from the dredging activities considered here. PS Chinook that reside in the Puget Sound year-round, returning ocean-going adults, and out migrating juveniles from the other 18 MPGs may be exposed to dredging activities if they migrate close enough to the channels that would be dredged within the Puget Sound under this program. Dredging of Everett Harbor and the Snohomish River Navigation Channel is reasonably certain to expose individuals from the Skykomish River MPG and the Snoqualmie River MPG (Snohomish system) because the spawning areas for both MPGs are upstream of the project site (WDFW 2017a). Similarly, dredging of the Upper Duwamish Waterway is reasonably certain to expose individuals from the Green River MPG that must transit the project site as they migrate to and from upstream spawning areas (WDFW 2017a). The Snohomish system supports both summer (Skykomish) and fall run (Skykomish and

Snohomish) Chinook salmon. The Green River also supports both summer and fall run Chinook salmon.

In the Snohomish system, returning adult Chinook salmon tend to enter freshwater and migrate upstream early-June through mid-October, with spawning occurring between mid-September and mid-November. Both ocean- and stream-type Chinook salmon are present, with the majority being ocean-types. Juvenile ocean-types typically migrate out of their natal streams beginning in early-March of their first year of life, rearing in estuarine waters between early April and mid-July, then transitioning into their marine life stage. Conversely, stream-types tend to rear in fresh water for a year or more, and are likely to be present in the system year-round. Since 1965, the estimated total abundance for returning adult PS Chinook salmon has fluctuated between about 1,200 and 6,800 in the Skykomish River basin, and about 321 and 3,600 in the Snoqualmie River basin (WDFW 2017b), with the average trend being slightly negative in both MPGs, and natural productivity in the Skykomish considered below replacement for all years since the mid-1980s (NWFSC 2015). In 2016, the total numbers of returning adults were about 3,800 and 1,400 for the Skykomish and Snoqualmie Rivers, respectively (WDFW 2017b). Since 1997, the fraction of natural-origin spawners has fluctuated between about 34 to 83%, and 65 to 93%, respectively. The 2016 fraction of natural-origin spawners was about 62 and 74%, respectively (WDFW 2017b).

In the Green River, returning adult Chinook salmon enter freshwater and migrate upstream mid-June through November (peaking in August), with spawning occurring between mid-September and mid-November. Both ocean- and stream-type Chinook salmon are present, with the majority being ocean-types. Juvenile ocean-types typically migrate out of their natal streams between January and April of their first year of life, rearing in estuarine waters between early April and mid-July, then transitioning into their marine life stage (Gregory *et al*. 2004). Conversely, stream-types tend to rear in fresh water for a year or more, before quickly migrating to marine water between May and June. They are likely to be present in the system year-round. Since 1968, the estimated total abundance for returning adult PS Chinook salmon in the Green River basin has fluctuated between about 688 and 11,512 (WDFW 2017b), with the overall trend being negative (NWFSC 2015). Since 2003, the fraction of natural-origin spawners has fluctuated between about 21 to 53%. In 2016, the total numbers of returning adults was about 10,063, 25% of which were natural-origin spawners (WDFW 2017b).

2.2.2 Puget Sound (PS) Steelhead

The PS steelhead distinct population segment (DPS) was listed as threatened on May 11, 2007 (72 FR 26722). The recovery plan for this DPS has not yet been completed. In 2013, the Puget Sound Steelhead Technical Recovery Team (PSSTRT) identified 32 demographically independent populations (DIPs) within the DPS, based on genetic, environmental, and life history characteristics, and distributed those DIPs among three geographically-based major population groups (MPG); Northern Cascades, Central and South Puget Sound; and Hood Canal and Strait de Fuca (Myers *et al.* 2015) (Table 4). In 2015, the PSSTRT developed viability criteria for the DPS, concluding that the DPS is at “very low” viability; with most of the 32 DIPs and all three MPGs at “low” viability based on widespread diminished abundance, productivity, diversity, and spatial structure when compared with available historical evidence (Hard *et al.* 2015).

Based on the PSSTRT viability criteria, the DPS would be considered viable when all three component MPG are considered viable. A given MPG would be considered viable when: 1) 40 percent or more of its component DIPs are viable; 2) mean DIP viability within the MPG exceeds the threshold for viability; and 3) 40 percent or more of the historic life history strategies (i.e., summer runs and winter runs) within the MPG are viable. For a given DIP to be considered viable, its probability of persistence must exceed 85 percent, as calculated by Hard *et al.* (2015), based on abundance, productivity, diversity, and spatial structure within the DIP.

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

Abundance and Productivity: Available data on total abundance since the late 1970s and early 1980s indicate that abundance trends have fluctuated between positive and negative for individual DIPs. However, low productivity persists throughout the 32 DIPs, with most showing downward trends, and a few showing sharply downward trends (Hard *et al.* 2015, NWFSC 2015). Since the mid-1980s, trends in natural spawning abundance have also been temporally variable for most DIPs but remain predominantly negative, and well below replacement for at least 8 of the DIPs (NWFSC 2015). Smoothed abundance trends since 2009 show modest increases for 13 DIPs. However, those trends are similar to variability seen across the DPS, where brief periods of increase are followed by decades of decline. Further, several of the upward trends are not statistically different from neutral, and most populations remain small. Nine of the evaluated DIPs had geometric mean abundances of fewer than 250 adults, and 12 had fewer than 500 adults (NWFSC 2015). Over the time series examined, the over-all abundance trends, especially for natural spawners, remain predominantly negative or flat across the DPS, and general steelhead abundance across the DPS remains well below the level needed to sustain natural production into the future (NWFSC 2015). The PSSTRT recently concluded that the PS steelhead DPS is currently not viable (Hard *et al.* 2015). The DPS’s current abundance and productivity are considered to be well below the targets needed to achieve delisting and recovery. Growth rates are currently declining at 3 to 10% annually for all but a few DIPs, and the extinction risk for most populations is estimated to be moderate to high.

Table 4. PS steelhead Major Population Groups (MPGs), Demographically Independent Populations (DIPs), and DIP Viability Estimates (Modified from Figure 58 in Hard et al. 2015).

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

Limiting Factors: Factors limiting recovery for PS steelhead include:

- The continued destruction and modification of steelhead habitat
- Widespread declines in adult abundance (total run size), despite significant reductions in harvest in recent years
- Threats to diversity posed by use of two hatchery steelhead stocks (Chambers Creek and Skamania)
- Declining diversity in the DPS, including the uncertain but weak status of summer run fish
- A reduction in spatial structure
- Reduced habitat quality through changes in river hydrology, temperature profile, downstream gravel recruitment, and reduced movement of large woody debris

- In the lower reaches of many rivers and their tributaries in Puget Sound where urban development has occurred, increased flood frequency and peak flows during storms and reduced groundwater-driven summer flows, with resultant gravel scour, bank erosion, and sediment deposition
- Dikes, hardening of banks with riprap, and channelization, which have reduced river braiding and sinuosity, increasing the likelihood of gravel scour and dislocation of rearing juveniles

<u>PS Steelhead within the Action Area:</u> The wide spatial and temporal distribution of COE maintenance dredging work in the Puget Sound suggest that adults and juveniles from many of the 32 extant PS steelhead DIPs may be exposed to program-related dredging activities. However, current understanding of PS steelhead life history suggests that juvenile steelhead spend very little time in estuarine and nearshore marine environments. Unlike the Chinook discussed above, juvenile steelhead rear in freshwater for extended periods before migrating to the marine environment. They pass quickly through estuarine and nearshore marine environments in favor of deeper marine waters, and do not typically follow the shoreline once they leave their natal streams. The natal streams of the Elwha DIP, the Strait of Juan de Fuca DIP, and the Dungeness DIP are west (oceanward) of the Puget Sound dredging sites, and the migration routes of the juveniles and adults of those DIPs are unlikely to include any of dredging sites considered in the Opinion. Therefore, individuals from those DIPs are unlikely to be exposed. Depending on the routes taken by emerging juveniles and returning adults of the Samish River and Bellingham Bay Tributaries DIP, the Nooksack DIP, the South Fork Nooksack DIP, and the Drayton Harbor Tributaries DIP, some individuals from those DIPs may be exposed to dredging activities, but most individuals are expected to follow routes to the north that would keep them away from the dredging activities considered here. Juveniles from the other 25 DIPs may be exposed to dredging activities if they migrate close enough to the channels that would be dredged within the Puget Sound under this program.

Dredging of Everett Harbor and the Snohomish River Navigation Channel is reasonably certain to expose individuals from the Snohomish/Skykomish, the Pilchuck, the Snoqualmie, the Tolt, and the North Fork Skykomish DIPs (Snohomish system) because the spawning areas for all of those DIPs are upstream of the project site (WDFW 2017a). Similarly, dredging of the Upper Duwamish Waterway is reasonably certain to expose individuals from the Green DIP that must transit the project site as they migrate to and from upstream spawning areas (WDFW 2017a). The Snohomish system supports both summer (Tolt and North Fork Skykomish) and winter run (Snohomish/Skykomish, Pilchuck, and Snoqualmie) steelhead. The Green River supports winter run steelhead.

Although the Snohomish River/Skykomish River winter run, the Snoqualmie River winter run; and the Green River winter run are among the eight DIPs with the highest geometric mean abundances for the period between 2010 and 2014, the abundance trend for the period between 1999 and 2014 is negative for all of the Snohomish system and Green River DIPs. Smoothed trends in abundance indicate modest increases for 13 DIP since 2009, including the winter runs in the Pilchuck and Green rivers. The Tolt River summer run is also showing early signs of an upward trend. However, several of the upward trends are not statistically different from neutral, and most populations remain small. For example, the Tolt River summer run is among the six DIPs with the smallest populations (NWFSC 2015).

Since 1981, the estimated total abundance for returning adult PS steelhead in the Snohomish system has fluctuated between about 732 and 4,760; 279 and 1,706; and 614 and 2,536 in the Snohomish/Skykomish; Pilchuck; and Snoqualmie DIPs, respectively. The estimated total abundance for returning adult PS steelhead in the Tolt DIP has fluctuated between about 16 and 366 since 1985. No return data is available for the North Fork Skykomish DIP. In 2016, the total number of returning adults was about 1,312; 822; 986; and 16 in the Snohomish/Skykomish; Pilchuck; Snoqualmie; and Tolt DIPs, respectively (WDFW 2017c). In the Green River DIP, the estimated total abundance for returning adult PS steelhead has fluctuated between about 304 and 2,778 since 1978 (WDFW 2017c). In 2016, the total number of returning adults was about 2,145 (WDFW 2017c).

Based on information for the Snohomish Basin, returning summer-run adult PS steelhead tend to enter freshwater and migrate upstream from early-May through the end of October, whereas returning winter-run adults tend to enter freshwater from early-November through the end of April. Both runs spawn between the beginning of January and the end of June. Juvenile rearing occurs year-round, with most smolt outmigration occurring April through June (FFFSC 2013).

2.2.3 Southern Eulachon

The southern eulachon DPS was listed as a threatened species on March 18, 2010 (75 FR 13012). On April 1, 2016, NMFS the 5-year review concluded that the DPS's designation as threatened remained appropriate. The recovery plan for Southern eulachon was released September 6, 2017.

The major threats to eulachon are impacts of climate change on oceanic and freshwater habitats (species-wide), fishery by-catch (species-wide), dams and water diversions (Klamath and Columbia subpopulations) and predation (species-wide) (NMFS 2017a).

Spatial Structure and Diversity: The southern eulachon DPS includes all naturally-spawned populations that occur in rivers south of the Nass River in British Columbia (BC) to the Mad River in California. Core populations for this species include the Fraser, Columbia, and (historically) the Klamath Rivers. Eulachon leave saltwater to spawn in their natal streams late winter through early summer, and typically spawn at night in the lower reaches of larger rivers fed by snowmelt. After hatching, larvae are carried downstream and widely dispersed by estuarine and ocean currents. Eulachon movements in the ocean are poorly known, although the amount of eulachon bycatch in the pink shrimp fishery seems to indicate that the distribution of these organisms overlap in the ocean. The southern DPS includes four major subpopulations: Columbia, Klamath, Fraser, and British Columbia. However, these subpopulations do not include all spawning aggregations within the DPS. For instance, eulachon have also been documented in Redwood Creek and the Mad River in California, the Umpqua River and Tenmile Creek in Oregon. Along the Washington coast, eulachon spawning has been documented in the Bogachiel, Chehalis, Humptulips, Naselle, Quinault, and Wynoochee rivers, as well as the Elwha River in the Puget Sound (NMFS 2017a).

Abundance and Productivity: In the early 1990s, there was an abrupt decline in the abundance of eulachon returning to the Columbia River with no evidence of them returning to their former population levels since then (Drake *et al*. 2008). Persistent low returns and landings of eulachon in the Columbia River from 1993-2000 prompted the states of Oregon and Washington to adopt a Joint State Eulachon Management Plan in 2001 that restricts harvest when parental run strength, juvenile production, and ocean productivity forecast a poor return (Howell *et.al*. 2002). Despite a brief period of improved returns between 2001 and 2003, the returns and associated commercial landings have again declined to the very low levels observed in the mid-1990s (Joint Columbia River Management Staff 2009). Starting in 2005, the fishery has operated at the most conservative level allowed in the management plan. Although eulachon abundance in monitored rivers has generally improved, especially between 2013 and 2015, recent poor ocean conditions and the likelihood that these conditions will persist into the near future suggest that population declines may be widespread in the near future. Therefore, it is too early to tell whether recent improvements in the southern DPS of eulachon will persist (NMFS 2017a).

Limiting Factors: Limiting factors for this species include:

- Changes in ocean conditions due to climate change, particularly in the southern portion of the species' range where ocean warming trends may be the most pronounced and may alter prey, spawning, and rearing success.
- Climate-induced change to freshwater habitats
- Bycatch of eulachon in commercial fisheries
- Adverse effects related to dams and water diversions
- water quality,
- Shoreline construction
- Over harvest
- Predation

Southern eulachon within the Action Area: Adult eulachon typically measure about 7 to 9 inches (80 – 225 mm) long and weigh about 40 to 90 g. Newly-hatched larvae are about 4 to 8 mm long. Eulachon prey on planktonic organisms such as copepods and euphausiids, as well larval barnacles, worms, and fish. Larval eulachon also prey on phytoplankton (NMFS 2006b). Eulachon spawn atop sand and fine gravel substrates to which their eggs adhere. Attached eggs often move downstream through sediment transport processes as they mature. However, egg survival is greatly influenced by salinity, and exposure to salinity greater than 16 ppt, can be lethal (NMFS 2006b). Therefore, eggs that don't hatch before entering estuarine waters are increasingly unlikely to do so. Newly-hatched larvae are widely distributed throughout the water column as they passively drift downstream toward marine waters (Howell *et al*. 2002). As reported above, eulachon spawning is reported in the Chehalis, Humptulips, and Wynoochee rivers, all of which flow into Grays Harbor. WDFW estimates that about 272,000 eulachon spawned in the Chehalis River in 2015 (NMFS 2017a). NMFS (2017a) refers to an undated anonymous source (prior to 2006) that reported eulachon spawning in the Bogachiel River, a tributary of the Quillayute River. WDFW staff suggest that it would not be surprising for eulachon to spawn in the Quillayute system, and the rarity of documentation is more likely due to the absence of surveys in the watershed than an absence of spawning activity (P. Dionne personal communication 2017). NMFS knows of no documented eulachon spawning in or upstream of any of the Puget Sound navigation channels considered in this Opinion.

Timing of eulachon entry into the spawning rivers is not clearly understood. It appears to be related to water temperature and the occurrence of high tides. Spawning is reported to occur at temperatures from 4° to 10°C. Run timing in the Fraser River (based on harvest rates) tended to be earlier in years with warmer temperatures. To the south of Grays Harbor, spawning runs typically occur in the Columbia River between January and March (NMFS 2017a). Larval eulachon typically emigrate from the Columbia River during January through May, peaking in April (Howell *et.al*. 2002). To the north, eulachon runs in central and northern British Columbia typically occur in late February or March. Fraser River runs occur in April or May (NMFS 2017 a). Larval eulachon typically emigrate from the Fraser River during April to Mid-June, peaking in the last two weeks of May (McCarter and Hay 2003). Based on the information for nearby larval emigration, the Quinault Indian Nation Department of Fisheries sampled for eulachon larvae in the Chehalis River and three of its tributaries (Hoquiam, Wishkah, and Wynoochee Rivers) late January through early May in 2013 and 2014. Eulachon larvae were present but not abundant. The survey data also suggests that emigration may have begun prior to the start of the sampling periods (Quinault Indian Nation 2014). The available information suggests that adult eulachon would leave marine waters and enter Grays Harbor and the Quillayute River as early as the beginning of January as they migrate to their freshwater spawning habitats upstream on the channels. Out-migration of larvae is likely to be complete by the end of June.

2.2.4 Southern Green Sturgeon

The southern green sturgeon DPS was listed as threatened on April 7, 2006 (71 FR 17757). We have released a recovery outline for this species (NMFS 2010b). We completed a 5-year status review for this DPS in 2015 and recommended the DPS retain its threatened classification.

Spatial Structure and Diversity: Two green sturgeon DPSs have been defined, the southern DPS (Sacramento River spawning population), and a northern DPS (spawning populations in the Klamath and Rogue rivers). Southern green sturgeon includes all naturally-spawned populations of green sturgeon that occur south of the Eel River in Humboldt County, California. Telemetry data and genetic analyses suggest that southern green sturgeon generally occur from Graves Harbor, Alaska to Monterey Bay, California (Lindley *et al*. 2008 and 2011; Moser and Lindley 2007). Within this range, southern green sturgeon most frequently occur in coastal waters near San Francisco and Monterey bays, and coastal waters of Oregon, Washington, and Vancouver Island, BC (Huff *et al*. 2012). Within the nearshore marine environment, tagging and fisheries data indicate that green sturgeon of both DPSs prefer depths less than 110 m (Erickson and Hightower 2007).

Abundance and Productivity: Based on recent studies, the current estimate of southern green sturgeon abundance is between 824 and 1,872 spawning adults. However, no comparable data are available to assess whether this reflects an improvement or a decline in the species' status (NMFS 2015b). In the Sacramento River, southern green sturgeon spawners utilize a limited area of the river compared to potentially available habitat. The reason for this is unknown. The limited habitat use is considered problematic because it makes a significant portion of the adult population more vulnerable to a catastrophic environmental event, or may expose them to targeted poaching within that limited area.

Limiting Factors: The greatest extinction risk for the southern green sturgeon is that the DPS consists of a single known population that spawns in a limited portion of the Sacramento River. Limiting factors for this species include:

- Limited freshwater spawning habitat
- Degradation of freshwater and estuarine habitat, including adequate water flows, contamination, elevated temperature, and non-native species
- Water diversions within the Sacramento and Feather Rivers and in the Sacramento River Delta
- Illegal harvest
- Post-capture impacts on fish that are released after unintentional capture in recreational and commercial fisheries for other species

Southern green sturgeon within the Action Area: Most southern green sturgeon are thought to migrate annually along the continental shelf, ranging between Graves Harbor, Alaska and Monterey Bay, California. They typically travel north past the US-Canada border in the fall and return in the spring. They are known to concentrate during the summer and early fall in the estuaries of certain rivers and coastal bays, particularly in the Umpqua and Columbia River estuaries, Willapa Bay, Grays Harbor, and the Fraser River estuary (Lindley *et al*. 2011; NMFS 2015b). Green sturgeon move extensively within an individual estuary and between different estuaries during the same season (Moser and Lindley 2007; NMFS 2015b).

Subadults and adults of both the northern and southern green sturgeon DPSs regularly forage in Grays Harbor, primarily May through October (Lindley *et al*. 2011). The green sturgeon that gather in Grays Harbor are likely between 2.5 and 8.5 feet (75 to 250 cm) in length (Moser *et al*. 2016). The habitat preferences of both DPSs are essentially identical, and their proportions in Grays Harbor are believed to be about equal (NMFS 2015b). Although not specifically described in the available literature, it is likely that some individuals of the southern DPS enter the Puget Sound, and coastal marine critical habitat is designated for this species within the Puget Sound. However, Grays Harbor is the only area considered in this Opinion that has been designated as critical habitat for southern green sturgeon.

Subadult and adult green sturgeon generally inhabit specific areas of coastal estuaries near or within deep channels or holes, moving into the upper reaches of the estuary, but rarely into freshwater (NMFS 2015b). Although there is variability, green sturgeon tend to prefer deep channels and pools during daylight and during periods of high flow, generally swimming near the bottom, and to occupy shallow areas at night and/or during low flows (NMFS 2015b). In the Rogue River, green sturgeon preferred to hold in deep pools or low gradient reaches and off-channel coves greater than 5 m deep and with low current, to conserve energy and feed on available food resources. Green sturgeon in coastal estuaries often move into tidal flats to feed, particularly at night (NMFS 2015b). White sturgeon tracking studies in the lower Columbia River, support this, indicating that white sturgeon were active during all times of the day, and that they moved into shallower areas during the night. Moser and Lindley (2007) suggest that green sturgeon movements and habitat use may also be based on the availability of certain areas due to tides. Green sturgeon typically feed on benthic invertebrates including shrimp, mollusks, and amphipods (Moyle *et al*. 1992). Burrowing shrimp are a major component of the green sturgeon diet in coastal estuaries, and green sturgeon feeding pits tend to be most dense in areas of high burrowing shrimp abundance (NMFS 2015b). Green sturgeon also opportunistically feed on several fish species, such as anchovies, herring, juvenile lingcod, and sand lance (Dumbauld *et al.* 2008; Erickson and Hightower 2007; Moyle 2002). Although the specific habitat use of southern green sturgeon in Grays Harbor and in Puget Sound estuaries have not been confirmed, they are likely to be similar to those described above.

2.2.5 Critical Habitat

This section describes the status of designated critical habitat 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). NMFS designated critical habitat for PS Chinook salmon and HCSR chum salmon on September 2, 2005 (70 FR 52630); for southern green sturgeon on October 9, 2009 (74 FR 52300); for PS/GB bocaccio on November 13, 2014 (79 FR 68042); and PS steelhead on February 24, 2016 (81 FR 9252). The action area has been excluded from designation for southern Pacific eulachon critical habitat (76 FR 65324; October 20, 2011).

Due to the wide-spread nature, and varying locations of the eight navigation channels considered in this Opinion, the affected critical habitat varies between project locations. For clarity, the project sites are grouped here based on the location of the sites and the critical habitat that would be affected. Grays Harbor, Westhaven Cove, and the Quillayute River are all located on the west coast of the state. The rest of the sites are all located within Puget Sound. The proposed work at Grays Harbor Navigation Channel and Westhaven Cove Small Boat Basin would affect designated critical habitat for southern green sturgeon. There is no designated critical habitat for listed species under NMFS jurisdiction in the Quillayute River Channel. The proposed work at Port Townsend Harbor would affect designated critical habitat for PS Chinook salmon, HCSR chum salmon, and PS/GB bocaccio. The proposed work at Keystone Harbor Federal Navigation Channel would affect critical habitat for PS Chinook salmon and PS/GB bocaccio. The proposed work at the Swinomish Federal Navigation Channel would affect designated critical habitat for PS Chinook salmon. The proposed work at Everett Harbor and Snohomish River Navigation Channel would affect designated critical habitat for PS Chinook salmon and PS steelhead. The proposed work at the Upper Duwamish Waterway would affect designated critical habitat for PS Chinook salmon and PS steelhead.

Southern green sturgeon critical habitat

Southern green sturgeon critical habitat includes: (1) Coastal marine areas: All US coastal marine waters out to the 60 fathom (360 feet, 110 m) bathymetry line (relative to MLLW), extending from Monterey Bay, California north and east to include waters in the Strait of Juan de Fuca, Washington. Critical habitat in the Puget Sound stops east of Port Townsend, and does not extend past the west shores of Whidbey and Fidalgo Islands, nor does it extend north past Anacortes, or the southern shores of the San Juan Islands, with the exception of a short distance along the southeast shore of Lopez Island; (2) Freshwater riverine habitats: Much of the Sacramento River, several of its tributaries, and several artificially constructed water conveyances that connect to the Sacramento River in California; (3) Sacramento-San Joaquin Delta: The lower Sacramento and San Joaquin Rivers at their confluence, and several oxbows and artificially constructed water conveyances that connect to those rivers in California; and (4) Coastal bays and estuaries: All tidally influenced areas up to the elevation of mean higher high water, including, but not limited to, areas upstream to the head of tide endpoint in (i) San Francisco Bay, San Pablo Bay, and Suisun Bay, California (interconnected waters east of the Golden Gate Bridge and downstream from the Sacramento-San Joaquin Delta); (ii) Humboldt Bay, California; (iii) Coos Bay, Oregon; (iv) Winchester Bay, Oregon; (v) Yaquina Bay, Oregon; (vi) Nehalem Bay, Oregon; (vii) Lower Columbia River estuary, Oregon and Washington; (viii) Willapa Bay, Washington; and (ix) Grays Harbor, Washington. Southern green sturgeon CH that may be affected by dredging the Grays Harbor Navigation Channel and the Westhaven Cove Small Boat Basin Harbor include: (1) Coastal marine areas and (2) Coastal bays and estuaries. The PBFs of southern green sturgeon critical habitat consist of (1) freshwater riverine systems; (2) estuarine habitats; and (3) nearshore coastal marine areas with the site attributes detailed in Table 5.

Table 5. Physical or biological features of southern green sturgeon critical habitat with the attendant site attributes and corresponding life history events.

Physical or Biological Features (PBF)		
PBF	**Site Attributes**	**Life History Event**
Freshwater riverine systems	Food resources Substrate type or size Water flow Water quality Migratory corridor [Water] depth Sediment quality	Adult spawning Embryo incubation, growth and development Larval emergence, growth and development Juvenile metamorphosis, growth and development
Estuarine habitats	Food resources Water flow Water quality Migratory corridor [Water] depth Sediment quality	Juvenile growth, development, seaward migration Subadult growth, development, seasonal holding, and movement between estuarine and marine areas Adult growth, development, seasonal holding, movements between estuarine and marine areas, upstream spawning movement, and seaward post-spawning movement
Nearshore coastal marine areas	Migratory corridor Water quality Food resources	Subadult growth and development, movement between estuarine and marine areas, and migration between marine areas Adult sexual maturation, growth and development, movements between estuarine and marine areas, migration between marine areas, and spawning migration

The Critical Habitat Review Team (CHRT) identified several activities that threaten the PBF of southern green sturgeon critical habitat in coastal bays and estuaries. Activities of concern include those that adversely affect prey resources, degrade water quality, or disturb bottom substrates.

Coastal Marine and Coastal Bay and Estuary PBF have been reduced by the loss or degradation habitats along the shore and in bays and estuaries due to shoreline development, maritime and fishing activities (bottom trawls), and the deterioration of upstream watersheds over the last 150 years (Stout *et al*. 2012; NWFSC 2015). The amount of tidal habitat has declined substantially relative to historical estimates, as has water quality. Changes in the watersheds due to land use practices have weakened natural watershed processes and functions and altered flow and sediment regimes including those flowing into coastal bays and estuaries (NMFS 2016a). Restoration activities have been ongoing since the 1990s, supported by NMFS, Oregon Watershed Enhancement Board, U.S. Fish and Wildlife Service, U.S. Forest Service, other state and federal agencies, and many landowners and stakeholders. Together, these different projects contribute to the restoration of habitat conditions in estuarine and tidal areas. However, there is little evidence for an overall improving trend. Within Grays Harbor, southern green sturgeon PBF are most impacted by in-water construction, dredging, commercial shipping, pollution (including impacts on burrowing ghost shrimp from the past use of carbaryl in association with aquaculture operations in the bay).

PS Chinook salmon, HCSR chum salmon, and PS steelhead critical habitat

PS Chinook salmon critical habitat: Critical habitat for PS Chinook salmon was designated in 16 freshwater subbasins and watersheds between the Nooksack Subbasin and the Dungeness/Elwha Watershed, inclusively, as well as 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 areas was also identified in the final rule, it was not designated as critical habitat for PS Chinook salmon. PS Chinook salmon critical habitat that may be affected by dredging at Port Townsend Harbor, Keystone Harbor Federal Navigation Channel, and the Swinomish Federal Navigation Channel include: (1) Estuarine areas and (2) Nearshore marine areas. PS Chinook salmon critical habitat that may be affected by dredging the Everett Harbor and Snohomish River Navigation Channel and the Upper Duwamish Waterway include: (1) Freshwater rearing, (2) Freshwater migration, (3) Estuarine areas, and (4) Nearshore marine areas.

HCSR chum salmon critical habitat: Critical habitat for HCSR chum salmon was designated in 5 freshwater subbasins and watersheds between the Skokomish Subbasin and the Dungeness/ Elwha Watershed, inclusively, as well as nearshore marine waters of Hood Canal, west along the Strait of Juan de Fuca to Dungeness Bay, and out to a depth of 30 meters. Although offshore marine areas was also identified in the final rule, it was not designated as critical habitat for HCSR chum salmon. HCSR chum salmon critical habitat that may be affected by dredging at Port Townsend Harbor is limited to: (1) Nearshore marine areas.

PS steelhead critical habitat: Critical habitat for PS steelhead was designated in 18 freshwater subbasins between the Strait of Georgia Subbasin and the Dungeness-Elwha Subbasin, inclusively. No marine waters were designated as critical habitat for PS steelhead. PS steelhead critical habitat that may be affected by dredging the Everett Harbor and Snohomish River Navigation Channel and the Upper Duwamish Waterway include: (1) Freshwater rearing, (2) Freshwater migration, and (3) Estuarine areas.
Table 6 lists the PBF and corresponding life history events for PS Chinook salmon, HCSR chum salmon, and PS steelhead critical habitat.

Table 6. Physical or biological features (PBF) of designated critical habitat for PS Chinook salmon, HCSR chum salmon, and PS steelhead, and corresponding life history events. Although nearshore and offshore marine areas were both identified in the respective FR, neither was designated as critical habitat for PS steelhead, and no offshore marine areas were designated as critical habitat for PS Chinook salmon or HCSR chum salmon.

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

Salmon and steelhead critical habitat assessments: 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 (LW) 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 LW recruitment (SSPS 2007).

Diking, agriculture, revetments, railroads and roads in lower stream reaches have caused significant loss of secondary channels in major valley floodplains in this region. Confined main channels create high-energy peak flows that remove smaller substrate particles and LW. 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. 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 (*e.g*., Elwha River dams block anadromous fish access to 70 miles of potential 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 LW to downstream areas (SSPS 2007). These actions tend to promote downstream channel incision and simplification (Kondolf 1997), limiting fish habitat. Water withdrawals reduce available fish habitat and alter sediment transport. Hydropower projects often change flow rates, stranding and killing fish, and reducing aquatic invertebrate (food source) productivity (Hunter 1992).

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

The nearshore marine habitat has been extensively altered and armored by industrial and residential development near the mouths of many of Puget Sound's tributaries. A railroad runs along large portions of the eastern shoreline of Puget Sound, eliminating natural cover along the shore and natural recruitment of beach sand (SSPS 2007).

Degradation of the near-shore environment has occurred in the southeastern areas of Hood Canal in recent years, resulting in late summer marine oxygen depletion and significant fish kills. Circulation of marine waters is naturally limited, and partially driven by freshwater runoff, which is often low in the late summer. However, human development has increased nutrient loads from failing septic systems along the shoreline, and from use of nitrate and phosphate fertilizers on lawns and farms. Shoreline residential development is widespread and dense in many places. The combination of highways and dense residential development has degraded certain physical and chemical characteristics of the near-shore environment (HCCC 2005; SSPS 2007).

The Critical Habitat Analytical Review Team (CHART) for the PS recovery domain determined that only a few watersheds in the Whidbey Basin (Skagit River/Gorge Lake, Cascade River, Upper Sauk River, and the Tye and Beckler rivers) are in good to excellent condition with no potential for improvement. However, most hydrological unit code level 5 (HUC_5) watersheds are in fair-to-poor or fair-to-good condition, with most of these watersheds having some or a high potential for improvement. The Snohomish River is considered to be in fair to good condition, with a high potential for improvement, whereas the Lower Green River (Upper Duwamish) is considered to be in fair to poor condition, with some potential for improvement.

<u>PS/GB bocaccio critical habitat</u>

Designated critical habitat for PS/GB bocaccio 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 ft (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 (DO) to support growth, survival, reproduction, and feeding opportunities. Deepwater critical habitat is defined as areas at depths greater than 98 ft (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 7 lists the PBF and corresponding life history events for PS/GB bocaccio critical habitat.

Table 7. Physical or biological features (PBF) 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 includes about 1,083 square miles (1,743 sq. km) of marine habitat in Puget Sound. Of which, about 438 square miles (706 sq. km) is 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. As of the late 1990s, shoreline development had impacted about 30% of the Puget Sound (Broadhurst 1998), and has increased since then (Cornwall and Mayo 2008). Shoreline development has been linked to reductions in invertebrate abundance and diversity, reduced forage fish reproduction, and reductions in eelgrass and kelp.

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) (WDOE 2010; COE 2015). Some of these contaminants are considered persistent bioaccumulative toxics (PBTs) that persist in the environment and can accumulate in animal tissues or fat. The WDOE estimates that Puget Sound receives between 14 and 94 million pounds of toxic pollutants annually (WDOE 2010).

2.3 Environmental Baseline

The "environmental baseline" includes the past and present impacts of all Federal, state, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of state or private actions which are contemporaneous with the consultation in process (50 CFR 402.02).

The proposed action would impact the area in and around eight navigation channels. Grays Harbor and Westhaven Cove are effectively collocated and are considered together here. All of the other channels are widely separated from each other, and are considered separately. Therefore, this environmental baseline assessment considers the areas at and around 1) Grays Harbor and the Westhaven Cove Small Boat Basin; 2) the Quillayute River; 3) Port Townsend Harbor; 4) Keystone Harbor; 5) the Swinomish Channel; 6) Everett Harbor and the lower Snohomish River; and 7) the Duwamish Waterway and the lower Green River.

2.3.1 Grays Harbor and the Westhaven Cove Small Boat Basin

The Grays Harbor and Westhaven Cove channels are located on the southwest coast of Washington, about 45 miles north of the mouth of the Columbia River. Grays Harbor is roughly triangular in shape, being about 12 miles wide at its western end, and coming to a point at the east end, about 15 miles from the Pacific Ocean (Figures 1 and 8). It covers about 94 square miles at high tide, and 38 square miles at low tide. The navigation channel is the deepest portion of the bay east of its entrance from the Pacific Ocean. Over 80 % of the harbor is less than 20 feet deep MLLW, and over 50 % has a depth of about 0 feet MLLW, consisting largely of mud flats (COE 2014). Low peninsulas extend from the north and south at the bay's western end, with a 2-mile wide gap separating them. The northern peninsula is largely covered by the community of Ocean Shores, while the southern peninsula supports the town of Westport. The communities of Hoquiam, Aberdeen, and Cosmopolis (combined – the Port of Grays Harbor) are all located near the mouth of the Chehalis River at the eastern end of the bay where the Chehalis River enters. Several other small towns and residential areas are situated on or near the bay.

The Chehalis River enters the bay at its east end. It is the largest of six tributaries flowing into the bay, and accounts for over 80 % of the fresh water in the estuary (COE 2014). The Hoquiam and Humptulips Rivers are among the lesser rivers and streams that flow into the bay. The Chehalis River originates in the Willapa Hills, the Black Hills, and lowlands east of I-5 near Centralia and has no glacial source of water. It generally flows westerly through conifer forests and open farmlands and is the major contributor of fluvial sediment to the inner portions of Grays Harbor. Water and sediment quality are identified as limiting factors in some portions of the Chehalis River basin.

The aquatic environment in Grays Harbor has been affected by anthropogenic activities since the mid to late 1800s. Since then, the bay and its surrounding watershed have been greatly altered. Large lumber mills, boat-building businesses, canneries, machine shops, and a busy port quickly developed along the shores of the bay (GGHI 2017). The navigation channel was first authorized in 1896, and has gone through numerous modifications, including deepening in 2016. The maintained navigation channel is 23.5 miles long. It begins outside of the harbor's entrance and extends into the lower mainstem of the Chehalis River. The Port of Grays Harbor currently has four marine terminals. The terminals include about 3,700 feet of vessel berthing space, and are supported by large, paved, cargo yards, the Port's on-dock rail system, and more than 104,000 square feet of covered storage (COE 2014), and the port is serviced by a short-line railroad that connect to the Burlington Northern and Union Pacific Railroads (GGHI 2017). Ship calls to the Port's terminals have increased dramatically in the last decade, totaling 102 ships in 2013, as compared to 8 in 2003 (Port of Grays Harbor 2014).

The Washington State Shore Zone Inventory Mapping System reports that the Grays Harbor area is heavily industrialized, and much of the shoreline has been altered by diking, armoring, and the construction of terminals. Several shoreline areas contain abandoned pilings, and scattered logs and broken piles. Grays Harbor is also identified in WDOE's 2014 Water Quality Assessment as a water of concern (Category 2) for fecal coliform bacteria, copper, dissolved oxygen, and temperatures (WDOE 2016a). Application of carbaryl in association with oyster aquaculture to control burrowing shrimp populations affects this important food resource, and possibly other prey species, for adult and subadult green sturgeon. Commercial shipping and pollution from point and non-point sources (e.g., agriculture, pulp mill runoff) may also reduce water quality with the discharge of contaminants into the water (NMFS 2009). Therefore, the current physical habitat conditions in the action area are degraded.

The Westhaven Cove Small Boat Basin is located just inside the south side of the entrance into Grays Harbor. It became operational in 1952, and is now home base for a large fleet of recreational, commercial, and pleasure boaters. The basin is protected by a system of rock jetties, and has two entrance channels. The entire shoreline within the marina is armored with riprap and/or bulkheads. Over 20 piers are installed within the basin to provide moorage availability for over 300 vessels. A public boat ramp and a commercial fuel pier are located within the basin, as are a small US Coast Guard (USCG) Station and the Westport Shipyard.

Half Moon Bay and South Beach disposal sites are both located near the south side the entrance into Grays Harbor (Figure 9). They are in nearshore subtidal habitats with maximum depths of about 45 feet. The substrate consists predominately of clean sand with various fractions of finer material and some organic material. Both sites are energetic areas that are exposed to waves and currents that transport bottom sediments along littoral drift corridors. Little to no macroalgae and/or rooted vegetation (eelgrass) occurs at either site. Infauna and epibenthic species include scattered individuals and patches of crustaceans (small shrimp, crabs (including Dungeness crabs)), mollusks (clams, snails, and nudibranchs), echinoderms (sea stars, urchins, and cucumbers), polychaete worms, and flat fish (flounder and sole) that inhabit fine sediment substrates.

The Point Chehalis Revetment Extension Mitigation site is located above the splash zone along the northeast corner of Half Moon Bay (Figure 9). The site is a gently sloped beach that consists of unconsolidated sediments, mostly of sand, with scattered driftwood along the high water line, followed by a rock riprap revetment and native and non-native brushy vegetation farther inland. The lower extent of the site is exposed to waves and currents that transport sediments along littoral drift corridors. Little to no attached macroalgae or rooted vegetation occurs in the intertidal zone at the site. The sandy substrate is inhabited by scattered individuals and patches of small burrowing crustaceans, mollusks, echinoderms, worms, and flat fish. Barnacles and other encrusting invertebrate organisms along with epilithic macroalgae inhabit some of rocks of the revetment that extend into the water north of the site.

Grays Harbor seasonally serves as resting and forage habitat for subadult and adult southern green sturgeon, and the action area has been designated as critical habitat for that species. Adult and larval southern eulachon also utilize Grays Harbor as a migratory corridor to travel between the ocean and upstream freshwater spawning habitat. The past and ongoing anthropogenic impacts described above have impacted green sturgeon and their critical habitat through reduced availability and quality of forage resources and resting habitat in the harbor as compared to pre-development conditions. Similarly, those past and ongoing anthropogenic activities have impacted both species in the harbor through exposure to reduced water and sediment quality caused by the introduction of pollutants, elevated water temperatures, and reduced dissolved oxygen levels. Those impacts have also likely reduced eulachon spawning success in upstream reaches.

2.3.2 Quillayute River Navigation Channel

This channel is located at the mouth of the Quillayute River, on the Northwest coast of the Olympic Peninsula (Figures 1 and 11). The Quillayute basin consists of four major sub-basins (Dickey, Sol Duc, Calawah, and Bogachiel) that drain over 800,000 acres of the northwestern slopes of the Olympic Mountains. The Bogachiel and Sol Duc Rivers meet about 5.6 river miles upstream from the coast to become the Quillayute River. The Dickey River joins the Quillayute about a mile upstream from the coast. The Calawah is a tributary of the Bogachiel. The regional ecotype is temperate rainforest, with an average annual rainfall between 120 and 140 inches, and current forest cover conditions in most of the watersheds are considered good to healthy. Much of the region remains heavily forested, and impervious cover caused by development and small population centers remains relatively limited (Quileute Tribe 2016).

The mainstem Quillayute River is a low gradient, low velocity river, with long gravel bars and little sinuosity. Most of the mainstem Quillayute River and some of its tributaries pass through private or tribal lands, the majority of which are dedicated to residential uses with portions devoted to commercial forestry. The towns of Forks and La Push are the largest communities within the basin. Forks is located just east of the confluence of the Calawah and Bogachiel Rivers. The Quillayute River forms the north boundary of the Quileute Indian Reservation, and the town of La Push is located on the south bank of the river at its mouth. Despite the relatively good environmental conditions in the region, several stream reaches within the Quillayute basin have been identified as Category 5 (polluted) waterbodies on the WDOE Water Quality Assessment 303d list for exceedance of water temperature criterion. A few Category 2 exceedances of criterion for dissolved oxygen, pH, and bacteria were also noted across the basin, particularly near the town of Forks (WDOE 2017b).

The navigation channel was first constructed in 1932. It is now about 3,500 feet long and 75 to 275 feet wide. A 1,070-foot long and 313-foot wide boat basin runs parallel to its upstream end (Figure 11). Both have a maintained depths of -10 feet MLLW. The Quillayute Spit is a naturally occurring depositional spit that extends from Rialto Beach to slightly south of Little James Island along the west side of the channel. A rubble mound structure is installed along its southernmost 3,200 feet. The spit is artificially maintained with dredged material along about 2,100 feet of its length. The Sea Dike is a rubble mound jetty that extends about 1,100 feet to the northeast from James Island to complete the western protection. South Jetty is a rubble mound structure that extends about 1,400 feet along the southeastern end of the channel. The boat basin supports the Quileute Tribe's small marina (about 80 slips) and a small USCG station. The primary commercial activities in the basin are commercial and recreational fishing and fish processing. During the summer, a significant number of recreational and transient commercial fishing vessels use the basin for moorage and re-fueling. The substrate within the channel and the boat basin consists of sand with a small fraction of gravel and cobble, and the waters are an estuarine mix of tidally influenced riverine waters.

The Quillayute Spit and First Beach sediment disposal sites are both located on moderately sloped beaches that consists of unconsolidated sediments, mostly of sand, with scattered driftwood along the high water line. A rubble mound structure runs along the spine of the spit. Disposal Site A, which is also serves as an unpaved parking area, is located upslope of the drift wood at First Beach. Native and non-native brushy vegetation extend south behind the driftwood. Both Quillayute Spit and First Beach are exposed to waves and currents that transport sediments along littoral drift corridors. Little to no attached macroalgae or rooted vegetation occurs in the intertidal zone at the sites. The sandy substrate is likely inhabited by scattered individuals and patches of small burrowing crustaceans, mollusks, echinoderms, worms, and flat fish. Barnacles and other encrusting invertebrate organisms along with epilithic macroalgae likely inhabit the intertidal and subtidal rocks of South Jetty. Surf smelt spawning has been documented on Rialto Beach and along the southern half of the beach south of La Push (WDFW 2017d).

Adult and larval southern eulachon seasonally utilize the Quillayute River channel as a migratory corridor to travel between the ocean and upstream freshwater spawning habitat. The past and ongoing anthropogenic impacts described above have likely impacted southern eulachon through exposure to reduced water and sediment quality caused by the introduction of pollutants, elevated water temperatures, and reduced dissolved oxygen levels, and those impacts have also likely reduced eulachon spawning success in upstream reaches.

2.3.3 Port Townsend Harbor

This channel (a.k.a. Boat Haven) is located in Port Townsend Bay, on the east side of the Quimper Peninsula, at the northeast tip of the Olympic Peninsula where the Strait of Juan de Fuca meets Admiralty Inlet. Port Townsend Bay is about six miles north to south and about 5 miles wide east to west. The city of Port Townsend is located along the northern shore of the bay, with the city of Port Hadlock-Irondale on the southwest shore. The Indian Island Naval Magazine and Marrowstone Island enclose the bay's east side. Chimacum Creek is the only named stream flowing into the bay.

The bay was discovered by western explorers in the late 1700s and immediately recognized for its safe moorage. The first non-native settlers arrived in 1851, and by the late 1800's Port Townsend was a well-known and very active seaport. Development died off in the 1890s when the railroads cancelled plans to connect with the port, after which the economy was largely based off of fishing, canning, shipping, and military development at Fort Worden. Ferry service to the port began in early 1900s and continues today with service between Port Townsend and Coupeville on Whidbey Island, and a paper mill that was built on the east shore of the bay in the late 1920s and remains in operation today. There are currently two marinas and a boatyard in operation in Port Townsend, including the Port Townsend Boat Haven. The shoreline around the bay is a mix constructed seawalls, rip rap revetment, piers, and gravel pocket beaches. A subtidal depths the substrate transitions to sands and muds. In many areas, sand and gravel recruitment from the feeder bluffs has been disconnected from shoreline erosional processes due to fill and seawalls associated with shoreline development.

The rocky irregular underwater topography in Admiralty Inlet causes strong tidal currents and turbulence outside of the bay, which combined with seasonal winds increases mixing in the bay. However, the currents near shore tend to be weak, and to move parallel to the shoreline; westerly at about 1 foot per second during ebb tide, and less than 0.5 foot per second during the flood. The water quality in the bay are classified as extraordinary for aquatic use, and WDOE’s 2012 303(d) list identified no water quality parameters of concern for Port Townsend Bay. Dissolved oxygen (DO) generally stays above the state standard of 7.0 mg/L in most years. However, there are many untreated stormwater outfalls around the bay, which likely introduce pollutants such as oils, nitrates, and suspended solids. WDOE analyses indicate that Port Townsend Bay has detectable levels of inorganic nitrogen (primarily nitrate), which tend to drop to scarcely detectable levels in summer due to uptake by phytoplankton. Elevated levels of fecal coliform are reported in the vicinity of the boat harbor.

Substrate conditions in Port Townsend Bay are generally soft bottom types. The northern portion of the bay tends to have coarser substrate, while the southern end of the bay tends to be muddy. The predominant subtidal substrate type in the project area is sand mixed with clam and barnacle shells and shell fragments. The existing Port Townsend Ferry Terminal (about 0.6 mile NE of the project site) was previously occupied by an oil company dock that was in existence since the early 1900s, with a bulk fuel terminal located nearby. Soil and groundwater contamination are known at the former bulk fuel terminal, and has been included in WDOE’s voluntary cleanup program since 2005. Washington State Ferries (WSF 2014) reports that subtidal sediment samples taken in 2006 from stations adjacent to the Port Townsend Boat Haven Marina had PAH concentrations of that exceeded the Washington State Sediment Management Standards (SMS) and Marine Sediment Quality Standards (SQS) (WAC 173-204-320), but the reported concentrations did not exceed the SMS for Puget Sound Marine Sediment Cleanup Screening Level (CSL) and minimum cleanup levels chemical criteria (WAC 173-204-520).

Port Townsend Harbor is located along a shoreline that is used as a migration corridor for juvenile salmon, and the action area has been designated as critical habitat for PS Chinook salmon, HCSR chum salmon, and PS/GB bocaccio. The past and ongoing anthropogenic impacts described above have impacted these species and critical habitats through shoreline development that has reduced the quantity and quality of the migratory and rearing habitat along the shoreline as compared to pre-development conditions. Additionally, past and ongoing anthropogenic activities have impacted these species and critical habitats through exposure to reduced water and sediment quality caused by the introduction of pollutants, elevated water temperatures, and reduced dissolved oxygen levels.

2.3.4 Keystone Harbor

This channel is located within a 6-acre Keystone-shaped harbor near the northwest corner of Admiralty Bay, along the central western shore of Whidbey Island (Figure 13), near the north end of Admiralty Inlet in the Puget Sound. It is oriented north to south, about 240 yards wide east to west, and about 350 yards deep north to south. A 470-foot long rock jetty is located along the southeast side of the entrance channel. The designated beach disposal site is located immediately east of the breakwater. The navigation channel was originally constructed in 1945, widened in 1971, and deepened in 1993. Within the harbor, WDOT maintains a ferry landing and Washington State Parks maintains a small recreational boat launch with two floating piers. Both facilities include paved parking areas. The surrounding landscape consists of the Fort Casey Historical State Park located to the west, Crockett Lake immediately to the north, with mostly agricultural lands and low-density housing beyond that. The nearest town is Coupeville, which is located across the island about three miles to the north of the harbor.

The shoreline within the harbor consists mostly of gently sloped depositional gravel and sand, with rock riprap along the shore either side of the ferry landing pier to armor against propeller wash scour. The intertidal zone areas that are not riprap are a mix of sand and gravel. The maximum depth of about -28 feet MLLW is located within the channel adjacent to the fixed dolphins of the ferry landing. Three distinct substrate areas exist within the harbor. The ferry lane and terminal near the center consist mostly of cobble and gravel with a few patches of sand/shell debris. The side slopes are composed of mostly sand and gravel with some cobble. The areas outside of propeller wash influence and not on a slope are composed of sand, mud, and wood debris. Outside of the harbor mouth, substrate is either gravel or cobble. The jetty along the east side of the harbor is composed of large, angular riprap boulders. The designated beach disposal site, and the intertidal and shallow subtidal substrate east of the jetty consists of clean sand, gravel, and cobble.

The dominant species on the harbor bottom outside of the channel is sugar kelp. Relatively sparse small patched of tightly anchored red algae is the prevalent macroalgae in the middle of the channel. The dominant marine algae on the jetty are bull kelp, sugar kelp, ribbon kelp, sea palm, sea lettuce, rockweed, red ribbon, and coralline algae. Eelgrass (*Zostera Marine*) is absent in the harbor. One small patch of eelgrass is present along the spit about 1,000 feet west of the harbor entrance. The closest documented large eelgrass bed is about 2 miles east of the harbor.

Nearshore currents near the harbor are generally westerly, with velocities of 2 to 3 feet per second. During flood flows, numerous eddies prevail in several locations of Admiralty Inlet, including Admiralty Bay where a counterclockwise rotating eddy is evident. The prevailing flood flow is toward the southwest off the entrance to Keystone Harbor. Unlike flood currents, the counterclockwise eddy is not present during ebb flows. Wave action is predominantly to the east. The wave action transports sediments that originate from the bluffs at Fort Casey State Park east to at the mouth of the harbor where they accumulate and require periodic dredging, with the dredged material being placed east of the breakwater to maintain sediment transport. WDOT

(2014) reports that the sediment chemistry had been analyzed a number of times over the past two decades and found to be suitable for open-water disposal. No specific water quality data is available for the harbor. However, WDOE has designated the marine waters of Admiralty Bay as extraordinary for aquatic life use, with no water quality parameters of concern have been identified in WDOE's 2012 303(d) list. The excellent tidal exchange between the harbor and the bay suggests that water quality within the harbor would be similar. Crockett Lake is a brackish water body that drains to Keystone Harbor via a culvert under SR 20. Therefore some level of salt- and freshwater mixing occurs within the harbor.

Keystone Harbor is located along a shoreline that is used as a migration corridor for juvenile salmon, and the action area has been designated as critical habitat for PS Chinook salmon and PS/GB bocaccio. The past and ongoing anthropogenic impacts described above have likely caused minor and highly localized impacts these species and critical habitats through reduced quantity and quality of the migratory and rearing habitat within the harbor, including reduced water quality caused by the introduction of low levels of pollutants related to vessel traffic in the harbor.

2.3.5 Swinomish Channel

The Swinomish Channel is located in the eastern Puget Sound. It is an 11-mile long, human-made, saltwater channel, east of Fidalgo Island and the north end of Whidbey Island, and northwest of the Skagit River delta. The channel connects Padilla Bay with Skagit Bay (Figures 1 and 14). Before creation of the channel, the waterway consisted primarily of shallow tidal sloughs, salt marshes, and mudflats known as the Swinomish Slough.

Non-native settlement of the Skagit delta began the mid-1860s. Since then, diking, draining, and filling have eliminated the overwhelming majority of the intertidal and salt marsh habitat, as well as estuarine and freshwater wetland habitats that historically occurred in the lower Skagit basin (La Conner 2014). The town of La Conner began as small trading post that was established on the west bank of the Swinomish slough in 1867, and grew into a small port town in the 1870s. The Swinomish Channel was authorized by Congress in 1892, and completed through dredging and diking in 1937. Between 1897 and 1973, a jetty and dike system was constructed and improved at the southern entrance of the channel to reduce siltation of the channel from the Skagit River and to protect the channel from high waves.

Today, the channel is maintained at -12 feet MLLW, and more than 30 percent of its shoreline consists of riprap, dikes, and bulkheads (La Conner 2014). The surrounding area consists largely of farmland and small communities that include the Swinomish Indian Reservation to the west, and the town of La Conner on the east bank. Several marinas, associated boat repair operations, and residential areas are also located along the channel. Two large oil refineries are located on March Point, near the north end of the channel, where State Highway 20 and the Burlington Northern Santa Fe (BNSF) railroad both span the channel on separate bridges. A third bridge spans the southern end of the channel at La Conner. The channel is routinely used by fishing boats, tug boats, recreational craft, and shallow-draft freight vessels.

Water exchange in the channel is predominantly driven by tidal movements, with currents alternating between north and south twice daily. Numerous small unnamed streams and ditches that drain the surrounding area discharge freshwater into the otherwise saltwater channel. The La Conner wastewater treatment plant also discharges to the Swinomish Channel (La Conner 2014). The Swinomish Channel is identified on the 2008 WDOE Water Quality Assessment, 303d list as a Category 5 (polluted) waterbody (La Conner 2014). Oyster tissue samples taken from the channel adjacent to agricultural lands north of La Conner in 1999 exceeded National Toxic Rule criterion for Benzo(a)anthracene and Chrysene. Also, single water samples taken near the north end of the channel in 2003 and 2004 exceeded 43 col/100mL for fecal coliform, and 1 water sample of 25 taken in the same area in 2008 was below 6 mg/L for dissolved oxygen (WDOE 2016a). Additionally, elevated levels of tributyltin and PAHs have been reported in Swinomish Channel shellfish (Johnson 2000 in La Conner 2014).

The substrate within the Swinomish Channel is dominated by mixed fine to course sediments, with marine vegetation and algae, including patchy beds of eelgrass, particularly along the west bank. Padilla Bay, at the north end of the channel, supports an estimated 8,000 acres of eelgrass. Invertebrates in inter- and subtidal zones within and adjacent to the channel include mussels, oysters, and barnacles that are common on hard surfaces, as well as polychaete worms, clams, burrowing shrimp, and crabs that are found in and on mud and sand (La Conner 2014).

The McGlinn Island Causeway and Jetty at the south end of the channel has largely prevented freshwater intrusion from the Skagit River into the Swinomish Channel, creating a sharp salinity contrast in the channel that acts as a physiological barrier for juvenile salmon. Juvenile salmon abundance is very low in the Swinomish Channel relative to other areas in the Skagit River delta, with low abundance at the southern end of the channel steadily declining to zero at the north end (Hinton et al 2008 and Yates 2001 in La Conner 2014).

The Swinomish Channel is occasionally used as a migration corridor for low numbers of adult and juvenile PS Chinook salmon and PS steelhead, and the action area has been designated as critical habitat for PS Chinook salmon. The past and ongoing anthropogenic impacts described above have created and maintained degraded migratory and rearing conditions along the majority of the channel’s length, and have impacted both species through exposure to reduced water and sediment quality caused by the introduction of pollutants, elevated water temperatures, and reduced dissolved oxygen levels.

2.3.6 Everett Harbor and Snohomish River Navigation Channel

This channel is located in Possession Sound, at the eastern edge of the Puget Sound, about 25 miles north of Seattle (Figures 1 and 15). The channel is about 6.6 miles long. It begins between the Everett Naval Station and the south end of Jetty Island, proceeds north between Jetty Island and the mainland, and follows the lower Snohomish River around the north end of the City of Everett.

The Snohomish River basin originates on the western slopes of the Cascade Mountains, at elevations of about 8,000 feet, and drains about 1.2 million acres. It flows westerly through broad, glaciated lowland valleys, and is the second-largest watershed that flows into the Puget

Sound. The basin includes the Skykomish and Snoqualmie rivers, which join to become the Snohomish River, and numerous smaller tributaries such as the Pilchuck and Tolt Rivers. Average annual precipitation ranges from about 35 inches in the western lowlands to over 120 inches in the headwaters. The Basin includes large portions of King and Snohomish Counties, which have a combined population of a bit over 2.9 million people, and an average annual growth rate of about 1.4 % since 2010 (King County 2017; Snohomish County 2017).

Since the mid-1850s, most of the land along the rivers and streams within the basin have been converted from dense old-growth forests to agricultural and low-density residential lands, with high density residential and industrial development occurring mostly near the Snohomish River estuary. Current land uses across the basin include forestry, agriculture, residential/ urban, infrastructure (roads and railroads; gas, water, and power lines), light industrial, recreation, and mining. Private and federal forest lands and Federal Wilderness Areas comprise almost three-quarters of the basin. Agricultural lands, only account for about 5% of the basin, but dominate the floodplains (SBRSF 2005). Rural residential development is also scattered throughout the lowlands and river floodplains, and many roads largely follow stream beds, resulting in the loss of mature riparian vegetation in many areas. The wide-scale loss of riparian forests across the basin has reduced the amount of large wood in the rivers, and most of the wood is old due to low recruitment and retention of new material. Although the highest concentration of urban and industrial development occurs at Everett, on the Snohomish River estuary, smaller cities such as Monroe, Sultan, Skykomish, Carnation Snoqualmie, and North Bend dot the rivers upstream into the mountains.

The basin is the major source of municipal water for the area, including the cities of Everett and Seattle. It is also the receptor for the effluent from numerous municipal wastewater treatment plants. Many stream reaches across the basin have been identified as Category 5 (polluted) waterbodies on the WDOE Water Quality Assessment 303d list for exceedance of criterion for water temperature, dissolved oxygen, pH, and bacteria. Many lower category exceedances of criterion for those and other contaminants, such as ammonia and numerous metals and chemicals were also noted across the basin, particularly in lower elevations near towns (WDOE 2017b).

In the area of the navigation channel, the Snohomish River is a low gradient, partially confined, meandering river. That section of the river and the Everett waterfront have been heavily impacted by over 100 years of development. Western explores first arrived in the area in the 1820s. Logging camps and sawmills were established in the 1850s. Permanent non-native settlement started in the 1860s. In the late 1880s and the 1890s, the federal government cleared navigation hazards from the river, and waterfront development dramatically increased, with the establishment of factories, smelting plants, pulp and paper plants, more saw mills, ship builders, maritime support services, marine shipping terminals, a thriving fishing industry, and the construction of what is now the Burlington Northern/Santa Fe (BNSF) railroad, which largely follows the coastline in this area. The COE constructed an offshore wood pile jetty in 1901 to protect the Port of Everett from the open waters of Port Gardner. Some of the jetty was replaced with rock. In 1903, the placement of dredged materials at the mouth of the estuary and along the western side of the jetty marked the creation of Jetty Island, which eventually covered all but the southernmost portion of the old jetty. The federal navigation channel was authorized in 1910. By

1918, Everett was a thriving seaport, and the town was formally established (History Link 2005; Port of Everett 2017a; SBRSF 2005).

Development of the City and Port of Everett continues to the present day. Currently, Everett is the 5th largest city on the Puget Sound. The Port of Everett is a deep-water commercial seaport, with eight shipping terminals, a marina, and industrial and commercial real estate. Between 2012 and 2016, the average numbers of annual vessel calls at the port was 107 ships and 66 barges (Port of Everett 2017b). The port also includes a public marina with 2,300 slips. The Everett Naval Station opened near the south end of the port in 1992, and is home to a USCG buoy tender, several frigates and destroyers, and one aircraft carrier. Jetty Island has been maintained and expanded over the years, largely through deposition of materials dredged from the federal channel. It is two miles long, half a mile wide, with an area of about 1,800 acres. The island provides summer recreation, but has no utilities or structures (Port of Everett 2017a - c).

Several areas adjacent to the Everett waterfront, the Port of Everett, and Naval Station Everett have been identified as Category 5 (polluted) on the WDOE Water Quality Assessment 303d list for exceedance of criterion for numerous substances, including dioxin, PCB, butyl benzyl phthalate, and fluoranthene. Many lower category exceedances of criterion for temperature, dissolved oxygen, pH, bacteria, and numerous metals and chemicals were also noted in this area (WDOE 2017b). The Port has identified six specific cleanup sites within their area of responsibility where previous waterfront activities has led to documented groundwater, and upland and marine sediment contamination. The primary contaminants found in upland and marine sediments include dioxins, furans, phenols, petroleum-based hydrocarbons including PAHs, marine paint additives such as PCBs, 1-methylnaphthalene, tributyltin (TBT), vinyl chloride, and metals such as arsenic, copper, lead, and mercury. Port projects to remediate identified contamination at those sites are in various stages of completion, implementation, and planning (Port of Everett 2017d).

The 6.6-mile long maintained channel is located in the Snohomish River estuary, where the water is a mix of tidally influenced riverine waters. It is about 150 feet wide, and 8 to 15 feet deep along most of its length, but includes two settling basins that are 20 to 40 feet deep, one of which is 700 feet wide (Figure 15). The channel accounts for about 27% of the 600 acres of aquatic habitat that exists in this reach of the Snohomish River estuary, and is likely the deepest portion of the river in most areas. The substrate within the channel consists predominately of clean sand with various fractions of finer material and some organic material. Little to no attached macroalgae or rooted vegetation is likely to occur within the channel due to periodic dredging, but likely occurs in areas adjacent to it. The sandy substrate is likely inhabited by scattered individuals and patches of small burrowing crustaceans, mollusks, and worms.

Jetty Island covers about 1,500 acres along the western side of southern third of the navigation channel. It consists of sandy dredged material that is indistinguishable from the material that makes up the Snohomish River delta. The island has a spit that protects a small intertidal area along its western side. Erosion and sediment transport processes have created extensive mudflats with intertidal and high salt marsh vegetation and an eelgrass meadow along its western side. The mudflats also support scattered individuals and patches of intertidal and subtidal crustaceans (small shrimp, crabs (including Dungeness crabs)), mollusks (bivalves, snails, and nudibranchs), echinoderms (sea stars, urchins, and cucumbers), polychaete worms, and flat fish (flounder and sole) that inhabit fine sediment substrates. The Riverside and Site "O" disposal sites are both located on formerly developed areas adjacent to but well above the bank-full level of the river. However, the hydraulic pipelines that would deposit the sediments would cross over salt marsh and riparian berm vegetation, as well as upland grasses to access those disposal sites.

Adult PS Chinook salmon and PS steelhead utilize the Everett Harbor and Snohomish River Navigation Channel as a migratory corridor to travel between the ocean and upstream freshwater spawning habitat. Out-migrating juveniles of both species also utilize the channel as a migratory corridor and, to a lesser extent, as rearing habitat. The action area has been designated as critical habitat for both of these species. The past and ongoing anthropogenic impacts described above have reduced instream flows, altered hydrologic processes, degraded floodplain and stream morphology, and degraded water quality through the introduction of pollutants, elevated water temperatures, and reduced dissolved oxygen levels in the action area and in upstream reaches. These impacts have had dramatic negative effects on the abundance and productivity of PS Chinook salmon and PS steelhead, and have degraded many PBF of critical habitat in this watershed.

2.3.7 Upper Duwamish Waterway

This channel is located in the Duwamish River, upstream from the Port of Seattle at the south end of Elliott Bay, in the southeastern Puget Sound (Figures 1 and 16). The section of channel that would be maintained under this program is limited to the upstream-most 3,300 feet of the 5.3-mile long Duwamish Waterway navigation channel. The Duwamish River is the downstream reach of the Green-Duwamish River basin, which originates on the western slopes of the Cascade Mountains, at elevations of about 5,000 feet, and drains about 309,000 acres. It flows northwesterly through broad, glaciated lowland valleys, before entering the Puget Sound. The basin includes the Green and Black Rivers, which combine at river mile 12 to become the Duwamish River. The water within the Lower Duwamish River is a well-stratified estuary that is driven by tidal actions and river flow. Fresh water moving downstream typically overlies the tidally influenced salt water entering the system.

Historically the Green-Duwamish watershed drained about 1 million acres, and included the Green, White, Black, and Cedar Rivers, which combined to become the Duwamish River before flowing into the Puget Sound (King County 2017b). Prior to development, the Duwamish River meandered widely, with well-developed connectivity to its floodplains, freshwater wetlands, and tidal marshes, and to an estuary that covered about 1,600 acres (WDOE 2017c & d). The watershed and surround lands have been heavily impacted by development since the 1850s. The first Western explores arrived in the area in the area in 1792. Others began arriving in the 1820s and 30s. Permanent non-native settlement started in the early 1850s. Logging and shipping of timber were the primary initial industries, with coal, fishing, wholesale trade, and shipbuilding becoming increasingly important over time. Seattle was incorporated in 1869. Tacoma was incorporated in 1875. The western terminus of Northern Pacific Railway's transcontinental railroad in Tacoma was completed in 1883.

In 1906, the White River was diverted to the Puyallup River, and the lower Duwamish was straightened and dredged to improve navigation and industrial development. Dredged materials were used to create Harbor Island to support the growing Port of Seattle, and to create usable lands by filling-in shallow marshes and tide flats, then armoring of the shorelines with levees, bulkheads, dikes, and other structures. This development resulted in the conversion of about 9.3 miles of meandering river into 5.3 miles of straightened channel with hardened banks. In 1911, the Cedar River was rerouted away from the Black River so that it flowed into the south end of Lake Washington. Regularly dredging of the Lower Duwamish River has occurred since 1916 to support ship navigation (WDOE 2017c & d).

The Lower Duwamish River now serves as a major shipping route for bulk and containerized cargo ships. The depth of the river varies from about -56 feet MLLW near its mouth, to -10 feet MLLW adjacent to the upper turning basin. The navigation channel ranges from -30 feet MLLW at Harbor Island to -15 feet MLLW in the upper turning basin. The shoreline along the majority of the Lower Duwamish River consists of steeply sloped riprap banks, concrete and sheet piling bulkheads, piers, wharves, and buildings that extend over the water (LDWG 2010). With the exception of Kellogg Island, which supports the largest contiguous area of intertidal habitat remaining in the Duwamish River, relatively small patches of intertidal habitats are intermittently dispersed outside the navigation channel, including small areas of low intertidal mudflats that are present in the reaches upstream of the 1st Avenue South Bridge. Subtidal sediments are predominantly sand near the upper turning basin at the upstream end of the channel, becoming sandy mud overlying clayey mud near the downstream end of the channel (LDWG 2010). The hard surfaces along the banks support populations of encrusting and burrowing organisms such as barnacles, mussels, and shipworms. Intertidal and subtidal sediments support populations of burrowing annelid worms, bivalves, and crustaceans, as well as epibenthic snails, crabs, shrimp, flatfish, sculpin, and numerous other fishes. Estuarine macrophytes are believed to be primarily limited to portions of Kellogg Island.

Decades of industrial activity and runoff from urban areas along both banks of the Lower Duwamish River have contaminated soils, groundwater, and river sediments. Numerous industries such as aircraft manufacturing, ship building and maintenance work, shipyard, marina, and aircraft operations, as well as sewer overflows and more than 100 storm drains have contributed to the contamination. Sediment contamination in the Lower Duwamish River has been characterized as localized areas with relatively high chemical concentrations (hot spots) separated by relatively large areas with lower chemical concentrations (LDWG 2010). Sediment contaminants include, but are not limited to, PCB, PAH, mercury, other metals, and phthalates (WDOE 2017d). The U.S. Environmental Protection Agency (USEPA) added shoreline areas and the river along the lower 5 mile portion of the Duwamish River to the Superfund National Priorities List in 2001, creating the Lower Duwamish Waterway Superfund Site. WDOE added the site to the Washington Hazardous Sites List in 2002. Virtually all of the Duwamish Waterway navigation channel is located within the bounds of the Lower Duwamish Waterway Superfund Site. Presently, USEPA is tasked with cleaning the river sediments, while WDOE is responsible for cleaning and controlling sources of pollution for most of the surrounding land areas (WDOE 2017e). The Duwamish River is on WDOE’s 2012 303(d) list polluted waterways for exceeding pH and water temperature standards. Upstream, the Green River is also on the list for exceeding the standards for dissolved oxygen and fecal coliform (King County 2017b).

Adult PS Chinook salmon and PS steelhead utilize the Upper Duwamish Waterway as a migratory corridor to travel between the ocean and upstream freshwater spawning habitat. Out-migrating juveniles of both species also utilize the waterway as a migratory corridor and, to a lesser extent, as rearing habitat. The action area has been designated as critical habitat for both of these species. The past and ongoing anthropogenic impacts described above have reduced instream flows, altered hydrologic processes, degraded floodplain and stream morphology, and degraded water quality through the introduction of pollutants, elevated water temperatures, and reduced dissolved oxygen levels in the action area and in upstream reaches. These impacts have had dramatic negative effects on the abundance and productivity of PS Chinook salmon and PS steelhead, and have degraded many PBF of critical habitat in the watershed.

2.4 Effects of the Action on Species and Designated Critical Habitat

Under the ESA, "effects of the action" means the direct and indirect effects of an action on the species, together with the effects of other activities that are interrelated or interdependent with that action, that will be added to the environmental baseline (50 CFR 402.02). Direct effects are caused by exposure to action-related stressors that occur at the time of the action. Indirect effects are effects caused by the proposed action that occur later in time. Interrelated actions are those that are part of the larger action and depend on the larger action for their justification. Interdependent actions are those that have no significant independent utility apart from the action that is under consideration" (50 CFR 402.02). No interrelated or interdependent actions are expected to result from the proposed action.

Due to the wide-spread nature, and varying locations of the eight navigation channels considered in this Opinion, the affected species and critical habitat vary between project locations. For clarity, this effects analysis is organized according to commonalities between sites based on their locations, and the listed species and critical habitat that would be affected. The navigation channels at Grays Harbor, Westhaven Cove Small Boat Basin (within Grays Harbor), and at Quillayute are considered together. The navigation channels at Port Townsend Harbor, Keystone Harbor, and the Swinomish Slough are considered together; and the navigation channels at Everett Harbor/Snohomish River and the Upper Duwamish Waterway are considered together.

<u>2.4.1 Grays Harbor, Westhaven Cove Small Boat Basin, and Quillayute River Navigation Channels</u>

Grays Harbor, Westhaven Cove Small Boat Basin, and Quillayute River Navigation Channels are all located along the Pacific Ocean coast of Washington State. Southern eulachon and southern green sturgeon inhabit all three project sites. Grays Harbor and the adjacent nearshore marine waters are designated critical habitat for southern green sturgeon. Southern eulachon spawning is documented in watersheds above all three channels, but not within them. Between late winter and early summer, adult and larval eulachon migrate through the Grays Harbor and Quillayute River Navigation Channels to move between their spawning areas and marine habitats. Although the Westhaven Cove Small Boat Basin is offset from the route likely to be taken by adult eulachon, larval eulachon may occasionally enter the boat basin because their movement is predominantly driven by currents. During the summer and early fall, adult and subadult southern green sturgeon concentrate in Grays Harbor to forage. As discussed below in

Section 2.11.1, the proposed work at these sites will have no meaningful impact on other listed marine species or their critical habitat, including the designated critical habitat for leatherback sea turtles located in Coastal marine waters near Grays Harbor and the mouth of the Quillayute River.

As described in Section 1.3 (Proposed Action), the COE or their contractors would operate hopper dredges annually between April 1 and June 31 in the lower reaches of the Grays Harbor channel, and clamshell dredges annually between July 16 and February 14 in the mid- to upper reaches of the channel. In-water sediment disposal would be done at the Point Chehalis and South Jetty dispersive open-water disposal sites, and the South Beach and Half Moon Bay nearshore subtidal disposal sites. A described above at section 1.3, sediment disposal at the DMMP-managed in-water disposal sites, Point Chehalis and South Jetty is covered under a programmatic consultation (NMFS 2015a) and is therefore not considered a part of the proposed action.

The COE's contractors would operate clamshell or hydraulic dredges in the Westhaven Cove Small Boat Basin about once every 10 years between July 16 and January 31, with dredged material disposed of at the Point Chehalis or the South Jetty dispersive open-water disposal sites (Figure 9). The COE's contractors would operate hydraulic pipeline dredges every 2 years between September 1 and February 28 in the Quillayute River Navigation Channel. Sediments would be disposed of via hydraulic pipeline to the Quillayute Spit and/or to an area inland at the jetty near First Beach (Figure 11). This information establishes temporal and spatial overlap of the proposed dredging and disposal activities with the expected presence of southern eulachon and southern green sturgeon. The proposed action may affect southern eulachon and southern green sturgeon through exposure to: (1) Entrainment; (2) Bucket strike; (3) Vessel collision; (4) Elevated noise; (5) Degraded water quality; and (6) Altered benthic habitat.

<u>2.4.1.1 Entrainment:</u> Entrainment is likely to adversely affect adult and larval eulachon as well as adult and sub-adult green sturgeon. Entrainment is the process where objects are enclosed and transported within some form of vessel or where solid particles are drawn-in and transported by the flow of a fluid. In this context, entrainment refers to the uptake of aquatic organisms by dredge equipment, as well as the transport of organisms by the downward motion of sediments during in-water disposal. Mechanical dredges entrain organisms that are captured within the clamshell bucket. Hydraulic dredges entrain organisms by suction. In-water disposal of sediments entrains organisms that are caught by the currents that are created within or very close alongside discharge plumes as they descend through the water column.

Both mechanical and hydraulic dredges commonly entrain slow-moving and sessile benthic epifauna along with burrowing infauna that are removed with the sediments. They also entrain algae and aquatic vegetation. There is little evidence of mechanical dredge entrainment of mobile organisms such as fish and sea turtles. In the Southeast Region of the US, where heavy dredging operation occur, only two live sturgeon (NMFS 2012) and two live sea turtles (NMFS 2011) are known to have been taken by clamshell dredging since 1990. This is likely due to a combination of factors that make exposure very rare. In order to be entrained in a clamshell bucket, an organism, such as a sturgeon or sea turtle must be directly under the bucket when it drops. The small size of the bucket, compared against the distribution of the organisms across the available habitat make this situation is very unlikely, and that likelihood would decrease after the first few bucket cycles because mobile organisms are most likely to move away from the disturbance. Further, mechanical dredges move very slowly during dredging operations, with the barge typically staying in one location for many minutes to several hours, while the bucket is repeatedly lowered and raised within an area limited to the range of the crane arm. Most fish in the vicinity of the dredge at the start of the operation would likely swim away to avoid the noise and activity. Based on the best available information, NMFS considers it highly unlikely that any of the species considered in this consultation would be struck or entrained by a mechanical dredge.

Numerous studies confirm the entrainment of fish and other organisms by hydraulic type dredges (Armstrong *et al*. 1981; Arseneault 1981; Boyd 1975; Dutta and Sookachoff 1975a & b; R2 Resource Consultants 1999). Although there is evidence of fish surviving entrainment (R2 Resource Consultants 1999), entrainment is often fatal. Braun (1974a & b) reported that nearly 99% of entrained juvenile fish were killed. This is not surprising, especially for larger organisms that are likely to be impacted by the cutterhead and/or pump impellers, before being dumped along with the dredged material into a hopper or onto a disposal area.

Hopper dredges operate for prolonged periods, generating continuous fields of suction forces around and under the dragheads while they are pulled along the substrate at relatively high speed as compared to other dredge methods. Entrainment of fish and other mobile organisms by a hopper dredge is believed to occur most often when the dragheads are out of firm contact with the channel bottom (Reine and Clarke 1998). Typical operations require the initial run-up of the pumps prior to the dragheads contacting the bottom, and the operation of the pumps after the dragheads are raised from the bottom at the end of a run to clear the dragarms. Other situations that may cause the loss of firm contact with the bottom include increases in depth that exceed the draghead's ability to remain flat against the bottom, along with wave action that may periodically pull the draghead away from the bottom. The potential for entrainment also increase with increased dredge size and flow rates. The likelihood of entrainment is also influenced by the swimming stamina and size of the individual fish at risk (Boysen and Hoover 2009), with swimming stamina being positively correlated with total fish length.

Hydraulic pipeline dredges also entrain fish, especially smaller fish that are less able to swim against the powerful currents near the cutterhead, which often unshrouded. Several studies confirmed of entrainment of juvenile salmon by hydraulic pipeline dredging in the Fraser River (Boyd 1975; Dutta and Sookachoff 1975b). However, most evidence of entrainment of larger fish and sea turtles comes from hopper dredge operations. This is probably the case because hopper dredging lends itself to entrainment monitoring. Hopper dredges tend to be relatively large vessels that can be equipped with screened inflow cages that allow observers to inspect recently dredged material. Additionally, the dredged material is at least temporarily retained on hoper dredges, as opposed to the direct and typically unobserved disposal of dredged material by a hydraulic pipeline dredge.

In-water sediment disposal with bottom-dump hopper dredges and barges for Grays Harbor and Westhaven Cove could cause entrainment at: Point Chehalis and South Jetty Open-Water Placement sites; and South Beach and Half Moon Bay nearshore subtidal disposal sites.

Sediment disposal for the Quillayute River Navigation Channel would be done by a hydraulic pipeline that discharges on to two relatively upland sites, and is therefore not expected to create conditions that might entrain fish.

During in-water disposal from a hopper dredge or bottom-dump barge, dredged material falls through the water column, and creates a plume that extends from the bottom of the vessel to the seafloor. The size of the discharge field is primarily determined by the size of the discharge port in the vessel, the volume of disposed material, the depth of water, and the length of the disposal run, if the vessel in moving. The Corps calculated the stationary dimensions of plumes that would be created by their hopper dredges Yaquina and Essayons. Based on a typical load of dredged material disposed in 60 feet of water, the disposal plumes would be about 20 and 30 feet in diameter at the bottom of hull, 180 and 240 feet in diameter at the seafloor, and have volumes of about 25,000 and 30,000 cubic meters for the Yaquina and Essayons, respectively.

Although the specific volume of discharged sediment may vary, the desire for efficiency encourages dredge operators to maximize the volume of dredged material that is removed per run. Typical loads are reportedly about 800 and 4,500 cubic yards of material for the Yaquina and Essayons, respectively (NMFS 2017b). A cubic yard of wet sand may weigh as much as 4,000 pounds (lbs). Therefore, for a single discharge event, the Yaquina would discharge about 3,200,000 lbs of material, whereas the Essayons would discharge about 18,000,000 lbs. Assuming that discharge would require about 5 and 8 minutes respectively, the Yaquina discharge rate would be over 10,000 lbs per second while the Essayons would discharge over 37,000 lbs per second. Assuming a depth of 60 feet, this would equate to an average of about 4 to 7 lbs of sediment, per square yard, per second. At a forward speed of 5 to 10 nautical miles per hour, the vessel would only move between 2.8 and 5.6 yards per second. Therefore, material would quickly accumulate across most of the plume's footprint, particularly toward the center of the plume and along the direction of travel.

The Corps predicts a plume velocity of about 11 feet per second at the start of disposal, and 7 feet per second toward the end because the slurry mixture becomes less dense over time (NMFS 2017b). Conservatively assuming a draft of 10 feet for the discharge vessel, the plume would first reach the bottom at 60 feet 4.5 seconds after release. At shallower depths, the weight per square yard per second would increase, while the time to react would decrease.

The bottom depths at the Grays Harbor disposal sites are all 60 feet or less, with the Half Moon Bay disposal sites being the shallowest with depths ranging from less than 10 to about 40 feet. Therefore, the width of the plume footprint would be narrower than described above, but the accumulation rates would be higher, and arrival times on the bottom would be shorter due to shallower depths at those sites. Fish that are above the point of discharge or are otherwise not directly below a discharge plume are likely to detect the plume and attempt to evade the descending material as a perceived threat. Based on the available research, fish are likely to initially dive and then initiate horizontal evasion. Fish that are below a discharge plume are likely to initially dive and then initiate horizontal evasion, or to simply move laterally if already on or near the bottom. The determining factor in avoiding entrainment will be whether the fish can swim fast enough to move out of the discharge field once the fish detects the threat. The risk of entrainment would increase with proximity to the center of the plume and/or to the seafloor.

Individuals that become entrained, or are unable to escape before contact with the substrate are likely to be buried under the sediments. The likelihood of injury or mortality would again increase with proximity to the center of the discharge field where depth and weight of the sediments would be greatest. Very small fish and larvae under or immediately next to the plume are likely to be entrained and killed.

Adult and/or larval eulachon will be entrained and killed during the planned dredging in all three navigation channels, and during in-water sediment disposal at Grays Harbor. Eulachon would be exposed to entrainment during their annual spawning migrations through the Grays Harbor and Quillayute River Navigation Channels in the late winter and early spring as they move between marine waters and their freshwater spawning habitats upstream of the channels. Out-migration of larvae is expected to be complete by the end of June.

Dutta and Sookachoff (1975b) report large numbers of adult eulachon being entrained by hydraulic dredging in the Fraser River. The best available information supports the understanding that small fish, such as eulachon and out-migrating juvenile salmonids (fry and smolts) are quite vulnerable to entrainment. Initial studies suggested that juvenile salmon were entrained in high enough numbers to threaten the affected runs (Boyd 1975; Dutta and Sookachoff 1975b), whereas later testing indicated much lower rates of entrainment (Arseneault 1981; Larson and Moehl 1990; McGraw and Armstrong 1990; R2 Resource Consultants 1999). Arseneault (1981) found that the number of entrained chum and pink salmon represented less than one tenth of a percent of the out-migrating salmonids. Some, if not most of the difference in entrainment rates is likely due to improved procedures to reduce entrainment, such as timing dredging to avoid out-migration peaks.

Based on the overlap between the expected occurrence of returning adult and out-migrating larval eulachon with planned use of hopper or hydraulic pipeline dredging in all three channels, and on the best available information about entrainment of eulachon and juvenile salmon during suction dredging, NMFS expects that low numbers of adult and larval eulachon will be entrained and killed by the planned dredging. Similarly, low numbers of adult and larval eulachon will be entrained and killed by in-water disposal of sediments at Grays Harbor. Although the available information is inadequate to accurately predict the number of eulachon that would be entrained, the available information supports the understanding that the number of individuals that would be taken would comprise a very small percent of the cohort they represent. Although suction dredging may also entrain eulachon eggs, the navigation channels are in waters with elevated salinity, which suggest that viable eulachon eggs are unlikely to be exposed to entrainment.

Adult and sub-adult southern green sturgeon would be entrained and killed during the planned dredging and in-water sediment disposal at Grays Harbor. As noted previously, the likelihood of entrainment is influenced by the size and swimming stamina of the exposed fish (Boysen and Hoover, 2009), with swimming stamina being positively correlated with the length of the fish. Juvenile sturgeon are relatively weak swimmers that are prone to bottom-holding behaviors that make them particularly vulnerable to entrainment (Hoover *et al*. 2011). Typically, sturgeon less than 8 inches (20 cm) in length are at the greatest risk of entrainment (Hoover *et al*. 2005; Boysen and Hoover 2009). The larvae and small sturgeon that are most vulnerable to entrainment typically remain in the estuaries of their natal streams, and are not likely to occur in

Grays Harbor. The sub-adult and adult green sturgeon that gather in Grays Harbor are likely to range between 2.5 and 8.5 feet (75 to 250 cm) in length (Moser *et al*. 2016).

The likelihood of entrainment increase with a fish's proximity to the dredge and the frequency of interactions. Although highly mobile and known to make vertical migrations within the water column, sub-adult and adult green sturgeon exhibit behaviors that increase their risk of entrainment. They are benthic feeders that are most often found on or near the bottom while foraging or while moving within rivers and estuaries. They also tend to rest and feed in deep channels and pools during daylight hours. Because the navigation channel provides the deepest waters in Grays Harbor, sturgeon density is likely to be highest where the dredging would be done, which would increase the risk of entrainment by exposing more sturgeon to the dredge.

Although the entrainment of large sturgeon by suction dredging is relatively rare, and has not yet been documented in Grays Harbor, entrainment of sub-adult to adult sized sturgeon has been recently documented in similar dredging projects on the east coast. During hydraulic dredging in Delaware River Ship Channel, a 5.7-foot long Atlantic sturgeon was fatally entrained in August 2014, and a 3-foot long short nose sturgeon was fatally entrained in July 2017 (NMFS 2017c). A 4-foot long Atlantic sturgeon was also fatally entrained in a hopper dredge operating in the Charleston Entrance Channel April 2016 (COE 2016b).

In the absence of site-specific information to quantify green sturgeon entrainment in Grays Harbor, NMFS used the entrainment rate of Atlantic sturgeon taken during hopper maintenance dredging in Savannah Harbor, Georgia. Atlantic sturgeon entrainment rates are a reasonable proxy for this consultation because the dredging at both sites is virtually identical, and because green sturgeon biology and life history are similar to that of Atlantic sturgeon. The 2011 biological opinion for the Savannah Harbor Expansion Project (SHEP) estimated sturgeon catch-per-unit-effort (CPUE) based on two observed sturgeon entrainments by hopper dredging that removed 13,325,513 cubic yards of material between 2007 and 2009. The CPUE (0.00000015 sturgeon per cubic yard) was then multiplied by the estimated number of cubic yards to be dredged over the life of the SHEP project, resulting in the estimated entrainment of four Atlantic sturgeon over 3 years of hopper dredging (NMFS 2011). However, five Atlantic sturgeon were lethally taken over the first two years of dredging, despite the employment of pre-trawling the dredging area, which captured and released an additional 17 Atlantic sturgeon and two turtles.

The 2017 amendment discussed several possible explanations for why the estimated level of entrainment was exceeded. The extension project included sustained intense dredging within a relatively small area that had never been dredged. In addition to increased dredging intensity, the newly-dredged area may have provided good forage habitat and increased the number of sturgeon congregated in the area. It is also possible that weather conditions may have increased sturgeon abundance in the area, or that Atlantic sturgeon may simply be more abundant in the area than previously thought. All of these situations would lead to an increased number of sturgeon encounters with dredging equipment.

The 2017 amendment also noted that observed takes likely underestimate total sturgeon mortality during hopper dredging, and included a correction factor to help account for un-observed entrainments. Although many dredging projects require onboard observers to monitor dredged material inflow and overflow screening baskets for hopper dredging projects, dredged material screening is only partially effective. The only sturgeon mortalities that are documented are those where body parts float or are large enough to be caught in the screens, and can then be identified as sturgeon parts. NMFS believes that some sturgeon killed by hopper dredges go undetected because some body parts are forced through the sampling screens by water pressure and are quickly buried in the dredged material. Additionally, some animals are crushed or killed but the takes go unnoticed because their bodies or body parts are not entrained by the suction. Therefore, observed entrainments likely under-represent the total number of interactions. In the absence of specific data for sturgeon, NMFS (2017d) applied data for sea turtle observations as the best available science, and estimated that about two out of three (66.7%) of the total number of entrained sturgeon would be detected.

Because the dredging in Grays Harbor would only partially overlap with the expected occurrence of green sturgeon, the volume of hopper-dredged material that is applied to the CPUE has been pro-rated here. However, to err in favor of the species, NMFS assumes that the green sturgeon may be present in the bay as early as May 1 each year. Based on that assumption, and on the information provided by the COE, as shown in Table 1, about 950,000 cubic yards of material would be removed annually by hopper dredge while green sturgeon are present in Grays Harbor. The total volume for the 25-year life of this consultation would be about 23,750,000 cubic yards.

Although NMFS (2017d) increased the estimated CPUE based on the observed takes during the first two years of dredging for the SHEP project, this opinion uses the CPUE from NMFS (2011, 0.00000015 sturgeon per cubic yard). NMFS believes that this lower CPUE would more accurately represent the maintenance dredging in Grays Harbor because it was based on maintenance dredging of a regularly-dredged channel, rather than high-intensity dredging of previously un-dredged habitat. Multiplying the CPUE by the expected cubic yardage and rounding to the nearest whole number, suggests that up to 4 observed green sturgeon entrainments are likely to occur over the life of this consultation. Application of a correction factor of 0.667 to account for unobserved entrainments suggests that a total of 6 green sturgeon entrainments are likely to occur. The available information about green sturgeon in Grays Harbor indicates that they are equally divided between the southern and northern DPS. This suggests that 3 of the 6 entrained green sturgeon would belong to the southern DPS. However, it is possible that all 6 individuals could belong to the southern DPS. Therefore, this assessment assumes that 6 southern green sturgeon would be entrained over 25 years of hopper dredging in Grays Harbor.

NMFS also expects that low numbers of sub-adult to adult southern green sturgeon will be entrained by the planned in-water disposal of sediments at Grays Harbor. Although it is unlikely that a green sturgeon would be under the disposal vessel for a single disposal run, it is reasonable to expect that over 25 years of dredge material disposal, some individuals could be under a disposal vessel at the time of release. Green sturgeon remain on or close to the substrate most of the time. As previously described, sediments would impact the bottom about 4.5 seconds after release in 60-foot deep water, and would cover an area about 180 to 240 feet across. Sustained swimming speed for green sturgeon is estimated at 1 foot per second per foot of body length (Niggemyer and Duster 2003). Darting or burst speed may be up to twice that. Burst speeds of 5 to 17 feet per second are estimated for 2.5- to 8.5-foot long green sturgeon. Assuming that a 2.5-

foot long sturgeon is at the center of a 180 wide disposal zone, it would take 18 seconds to reach the outer boundary of the zone. An 8.5 feet long sturgeon would take 5.3 seconds. Therefore, even if a sturgeon initiated its burst at the exact time of release, it would not fully escape from the center of the zone before sediments impact the bottom. The effects of entrainment will depend largely on the size and location of the fish within the disposal zone, and on the speed at which the fish initiates its flight response. Small sturgeon at the center of the zone at the time of release are likely to be quickly buried under many pounds of sediment and killed. Minimally, sturgeon that are within the zone but are not overwhelmed by the falling sediments would at experience various levels of stress related to avoidance behaviors. The available information is inadequate to predict the number of sturgeon that would be entrained during in-water sediment disposal. However, because the size of the in-water disposal areas make up a tiny fraction of the benthic habitat that green sturgeon would be distributed across in the action area, and across their range, the number of individuals that may be impacted by falling sediments is expected to a very small percent of the cohorts they represent.

2.4.1.2 Bucket Strike: The risk of eulachon and green sturgeon being struck by a clamshell bucket during mechanical dredging is highly unlikely for the same reasons described above under entrainment. To briefly summarize, in order to be struck by a clamshell bucket, eulachon or green sturgeon must be directly under the bucket when it drops. The small size of the bucket, compared against the distribution of the organisms across the available habitat make this situation is very unlikely, and that likelihood would decrease after the first few bucket cycles because the fish are most likely to move away from the disturbance.

2.4.1.3 Vessel Collision: The risk of collision between dredge-related vessels and eulachon and/or green sturgeon is highly unlikely. Although the transit speed of hopper dredges can reach up to about 20 miles per hour (mph), most other dredge-related vessel traffic, such as tugs and barges, would move much slower, especially when dredging, when hopper dredges move at about 3 mph, and barges are stationary. Further, unlike marine mammals and sea turtles, fish do not need to surface to breathe. Although eulachon and green sturgeon are known to make vertical migrations in the water column, neither are likely to remain near the surface where they would be at risk of collision. Further, as described in more detail below, both species are capable of detecting the vessel, are highly mobile, and capable of high-speed swimming that would be more than adequate to avoid collision with the vessel. Should adult eulachon or subadult or adult green sturgeon be close to the surface along the path of a moving dredge-related vessel, NMFS expects that exposed individuals would respond by quickly swimming down and away from the perceived threat, and therefore avoid collision.

2.4.1.4 Elevated Noise: Exposure to elevated noise would cause minor effects in adult and larval eulachon as well as adult and sub-adult green sturgeon. Elevated in-water noise at levels capable of causing detectable effects in exposed fish is likely to result from the use of hydrographic survey sonars, dredge operations, and vessel operations. These sources would cause a mix of impulsive and non-impulsive sounds at relatively high intensities, which can adversely affect marine life. Effects vary with the frequency, intensity, and duration of the exposure, the hearing characteristics of the exposed organism, and the context under which the exposure occurs. At low levels, effects may include the onset of behavioral disturbances such as temporarily masked communications or acoustic environmental cues, modified behaviors, and temporarily hearing damage (a.k.a. temporary threshold shift or TTS). At higher intensities, the effects include physical injury that can range from the onset of permanent hearing damage (a.k.a. permanent threshold shift or PTS) to mortality.

Sound is a mechanical disturbance consisting of minute vibrations that travel through a medium, such as air or water, and is generally characterized by several variables. Frequency describes the sound's pitch and is measured in hertz (Hz) or cycles per second. Sound level describes the sound's loudness. Loudness can be measured and quantified in several ways, but the logarithmic decibel (dB) is the most commonly used unit of measure, and sound pressure level (SPL) is a common and convenient term used to describe intensity. Root mean square (RMS) is the quadratic mean sound pressure over the duration of a single impulse. RMS includes both positive and negative values so that they may be accounted for in the summation of pressure levels (Hastings and Popper 2005). RMS units are often been used in the context of predicting behavioral effects in marine mammals. Sound exposure level (SEL) is a term that is used to describe the amount of sound energy a receiver is exposed to over time. The dB scale is exponential. For example, 10 dB yields a sound level 10 times more intense than 1 dB, while 20 dB is 100 times more intense, and 30 dB is 1,000 times more intense. Sound levels are compared to a reference sound pressure, based on the medium. The unit of measure is the micro-Pascal (μPa). In water, sound pressure is typically referenced to a baseline of 1 μPa (re 1 μPa), vice the 20 μPa baseline used for in-air measurements. As a rule of thumb, 26 dB must be added to an in-air measurement to approximate an in-water value for an identical acoustic source (Bradley and Stern 2008). For brevity, all further references to sound levels assume dB_{RMS} re 1 μPa, unless specified differently.

Transmission loss (attenuation of sound intensity over distance) varies according to several factors in water, such as water depth, bottom type, sea surface condition, salinity, and the amount of suspended solids in the water. Sound energy dissipates through mechanisms such as spreading, scattering, and absorption (Bradley and Stern 2008). Spreading loss refers to the apparent decrease in sound energy at any given point on the wave front because the sound energy is spread across an increasing area as the wave front radiates outward from the source. In unbounded homogenous water, sound spreads out spherically, losing as much as 7 dB with each doubling of range. However, when propagation is constricted by hydrographic or physical boundaries that create cylindrically spreading, attenuation may be reduced to about 3 dB for each doubling of range. Scattering refers to the sound energy that leaves the wave front when it "bounces" off of an irregular surface or particles in the water. Absorption refers to the energy that is lost through conversion to heat due to fiction. Irregular substrates, rough surface waters, and particulates and bubbles in the water column increase scattering and absorption loss. Although vertically bounded by the seafloor and the surface, shallow nearshore water is typically considered a poor environment for acoustic propagation due to the intense scattering and absorption that typically occurs there.

In the absence of location-specific transmission loss data, the equation $RL = SL – \#Log(R) – \alpha$ is often used to estimate the received level at a given range from the source (RL = received level (dB); SL = source level (dB); # = spreading loss coefficient; R = range in meters (m); and α = absorption coefficient in the water in dB(R/km). Spherical spreading loss is estimated with spreading coefficient of 20, and cylindrical spreading loss is estimated with spreading coefficient of 10. Acoustic measurements in nearshore environments support the use of a value close to 15, which is considered the practical spreading loss coefficient. The absorption coefficient is related to frequency. The absorption coefficient approaches 0 for frequencies below 10,000 Hz (1 kHz), so it is often left off of the equation. However it increases quickly with increases in frequency. In sea water, the absorption coefficient is about 1.2 at 12 kHz, 14.9 at 50 kHz, 61 at 200 kHz, and 101 at 400 kHz (Lurton and DeRuiter 2011). The practical spreading loss formula ($RL = SL - 15Log(R) - \alpha$) is used to estimate ranges for the acoustic sources considered in this Opinion.

Per the COE Hydrographic Surveying Engineer Manual (COE 2013), pre- and post-dredging hydrographic surveys of the channels would be completed using high-resolution seafloor-mapping echo-sounders. Echo-sounders operate at frequencies from about 12 to 1,000 kHz, with source levels between 210 and 240 dB re 1 μPa @1 m. The frequency and power settings typically depend on water depth. Frequencies of 12, 24, or 32 kHz, and source levels that may exceed 240 dB re 1 μPa @ 1 m are typically used in deep oceanic waters. Frequencies of 70 to 150 kHz are typically used on the continental shelf, whereas frequencies of 200 to 400 kHz are used in shallow water applications. The source levels for continental shelf and shallow water operations are around 210 to 220 dB re 1 μPa @ 1 m (Lurton and DeRuiter 2011). The most common transducer frequency range for use in typical COE river and harbor navigation projects is 200 to 208 kHz (COE 2013). The signal is typically a short-duration pulse measured in milliseconds. Single-beam systems are the most widely used depth measurement equipment for surveying COE navigation projects in rivers and harbors. However, multi-beam systems are expected gradually replace single beam systems for surveys of most deep-draft navigation projects. Single-beam systems transmit a single vertically-oriented conical beam that is typically 1.5° to 8° wide, whereas multi-beam systems have a fan-shaped pattern that is about 0.5° to 2° thick (along-track) and 120° to 150° wide (across-track).

Sound sources from vessel-borne dredging include the dredging equipment, as well as the vessels that are used to perform that work, such as the tugs used to move barge-mounted mechanical and hydraulic pipeline dredges. In the case of hopper dredges, the vessel and dredge are a single unit. The acoustic characteristics of mechanical dredging of coarse sand and gravel with a clamshell bucket are well described by Dickerson *et al.* (2001). The authors describe the in-water signature of bucket dredging as being between 20 and 1,000 Hz, and consisting of a series of six distinct sound sources: 1) winch and derrick movement noises related to lowering the bucket; 2) bucket contact with the substrate; 3) bucket digging into the substrate; 4) bucket closing; 5) winch and derrick movement noises related to raising the bucket; and 6) noise from dumping dredge spoils into the barge. This series repeats about every minute, with episodic breaks to reposition the barge or to dump the hopper. Of the sources, bucket impact with the substrate was the loudest. The authors expressed sound levels in dB_{RMS} only. Application of the practical spreading loss equation to the maximum dB_{RMS} SPL reported by Dickerson *et al.* suggests that the SL for bucket impact would be about 169 dB_{RMS}, with peak frequencies between about 60 and 370 Hz. The next loudest source would be 158 dB_{RMS}, with peak frequencies between about 40 and 370 Hz. for the bucket digging into the substrate. Reine *et al.* (2014a) report that mechanical backhoe dredging of limestone gravel produced impulsive and non-impulsive sounds. The loudest reported source was impulsive sound at a SL of 179.4 dB_{RMS} from the bucket's impact with the substrate. Relatively strong and continuous sound from the onboard engine and generators that was transferred through the ship's hull and in to the water were also reported, with a peak SL of

167 dB_{RMS} at 125 Hz. Hydraulic ram sounds from extending and retracting the excavator arm created peak SL of 164 dB_{RMS} around 620 Hz with a harmonic near 2,500 Hz.

The COE conducted acoustic monitoring of a hydraulic pipeline dredge equipped with a cutterhead while it removed medium-grained sand mixed with gravel from the Snohomish River navigation channel. The dredge had a diesel engine that powered a 3-stage hydraulic pump and the cutterhead, which rotated at 30 to 35 rotations per minute (RPM). The reported SL for hydraulic pipeline dredging was 165 dB_{RMS}, with the peak frequencies between about 25 and 350 Hz, coming from the engine and pump. With the cutterhead on, the dredge produced a secondary peak between about 4 and 6 kHz that reached about 150 dB_{RMS}. The COE also reported that spud placement caused episodic impulsive sounds with a SL of up to 186 dB_{RMS}, but they provided no frequency information (COE 2011a). Frequency analysis of un-attenuated in-water impact driving 16-inch steel pipe piles in Washington State indicates that the dominant acoustic energy is at frequencies below 4,000 Hz, with the majority of the energy below 1,600 Hz (Laughlin 2004). This is supported by the California Department of Transportation Compendium of Pile Driving Sound Data (Compendium, CalTrans 2009), which reports that sound levels above 2,500 Hz can be 15 to 20 dB lower than the recorded peaks for impact driving various sized pipe piles.

The acoustic characteristics of hopper dredging of sand and gravel are well described by Reine *et al*. (2014b). The report discussed the acoustic signatures for three hopper dredges while running empty and full, as well as while dredging and clearing the dragarms. The largest of the three ships, Liberty Island, is nearly identical in size and design as the Essayons, while the other two would be more representative of the smaller dredges that would be used to dredge Grays Harbor. The acoustic signatures of all three ships where largely similar. While in transit, the highest source levels ranged between 168 and 176 dB_{RMS}, with peak frequencies between 80 and 200 Hz for propulsion-related sources (i.e. engine and propeller cavitation), and secondary peaks that were associated with pumps and compressors between 400 and 1,100 Hz. While dredging, the highest source levels ranged between 172 and 175 dB_{RMS}, with peak frequencies between 100 and 250 Hz, with secondary peaks between 500 and 1,100 Hz. When flushing the pipes, the highest source levels ranged between 155 and 175 dB_{RMS}, with peak frequencies between 100 and 250 Hz, with secondary peaks between 400 and 1,000 Hz.

As indicated above, the loudest vessel noises typically consist of low frequency sounds from diesel and gasoline engines, and from propeller shafts and blades. These sources create a mix of impulsive and non-impulsive sounds most often below 200 Hz. Higher frequency non-impulsive sounds are also generated by pumps, fans, and hydraulic flow noises. McKenna *et al*. (2012) reported that the loudest sounds from large commercial ships (tankers, container ships, and bulk carriers) were propulsion-related (most often from propeller cavitation), at SL between 177 and 188 dB_{SEL}, with peak frequencies typically between 50 and 150 Hz. They also reported that the loudest sources were speed dependent, with sound levels increasing with speed. Richardson *et al*. (1995) reported a SL of 170 dB centered at 1,000 Hz for a tugboat moving a loaded barge. They also reported that vessel noise typically increases as vessel size, speed, and load increase. Blackwell and Greene (2006) described vessel noise as broadband in nature with propeller cavitation and flow noise causing tones at specific frequencies, generally below 50 Hz. They also reported broadband sound levels of 145 and 140 dB from tugboats moving loaded barges at distances of 50 and 100 m, respectively. Using the practical spreading loss suggests a SL of 170 dB for both instances.

Lurton and DeRuiter (2011), Richardson *et al*. (1995), and Blackwell and Greene (2006) didn't specify whether the reported sound levels were dB_{peak}, dB_{RMS}, or dB_{SEL}. This Opinion assumes that the reported values are in dB_{RMS}, because dB_{SEL} values are typically clearly identified when given, and to assume that they are dB_{peak} may underestimate the actual sound levels. All of the sound levels for dredging were reported in dB_{RMS}, with no dB_{peak} or dB_{SEL} sound levels given. The Compendium was used to help estimate dB_{peak} and dB_{SEL} based on dB_{RMS}, because that document provides dB_{peak}, dB_{RMS}, and dB_{SEL} sound levels for the same event for both impulsive and non-impulsive sources. Information in Compendium suggests that dB_{peak} is typically 10 to 15 dB higher than dB_{RMS}, regardless if the event is impulsive or non-impulsive. The difference between dB_{RMS} and dB_{SEL} depends on whether the source is impulsive or non-impulsive. For impulsive sources, dB_{RMS} is typically 10 to 15 dB higher than dB_{SEL}, while for non-impulsive sources the two values are identical. The maximum difference of 15 dB has been added to the available dB_{RMS} values to estimate dB_{peak}. The lesser difference of 10 dB was subtracted from the dB_{RMS} values to estimate dB_{SEL} for impulsive sources. For non-impulsive sources, dB_{RMS} and dB_{SEL} are assumed to be identical. The estimated dB_{peak}, dB_{RMS}, and dB_{SEL} SL for all of the expected sources are shown in Table 8, along with the source-specific ranges to the appropriate effects thresholds for fish and for marine mammals. To be conservative, the 120 dB_{RMS} marine mammal threshold for non-impulsive sounds was used instead of the 160 dB_{RMS} threshold for impulsive sounds for sources with characteristics of both impulsive and non-impulsive sound (Combination).

The best available information about the auditory capabilities of fish suggest that they can be initially separated into two groups: hearing specialists with capabilities up to about 4,000 Hz; and hearing generalists that 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). Hearing specialists are also thought to be about 20 dB more sensitive than the generalists. Pacific Coast hearing specialists include herring and relatives in the taxonomic order Clupeiformes (anchovies, herrings, menhaden, sardines, and shads) (Hastings and Popper 2005). All of the species considered in this Opinion are believed to be hearing generalists.

The criteria currently used by NMFS to estimate the onset of injury for fish exposed to high intensity impulsive sounds uses two metrics: 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; or exposure above 150 dB_{SEL}. Any 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 there is a difference between the ranges to the isopleths for effective quiet and SEL_{cum}, the shorter range shall apply.

Table 8. Estimated in-water dB_{peak}, dB_{RMS}, and dB_{SEL} Source Levels for project-related sound sources all of the expected sources, along with source-specific ranges to the appropriate effects thresholds for fish and for marine mammals.

Source	Acoustic Signature	Source Level	Threshold Range
Echo-sounders	200 kHz Impulsive	225 dB_{peak}	206 @ 15 m
		210 dB_{RMS}	160 @ 250 m
		200 dB_{SEL}	183 @ 12 m
Dredge Bucket Strike	< 370 Hz Impulsive	184 dB_{peak}	N/A
		169 dB_{RMS}	160 @ 4 m
		159 dB_{SEL}	150 @ 4 m
Bucket Dredge Engine	125 Hz Combination	182 dB_{peak}	N/A
		167 dB_{RMS}	120 @ 1,360 m
		167 dB_{SEL}	150 @ 14 m
Hydraulic Dredge Engine	< 370 Hz Combination	180 dB_{peak}	N/A
		165 dB_{RMS}	120 @ 1,000 m
		165 dB_{SEL}	150 @ 10 m
Hydraulic Dredge Cutterhead	4-6 kHz Combination	165 dB_{peak}	N/A
		150 dB_{RMS}	120 @ 100 m
		150 dB_{SEL}	150 @ 1 m
Spuds	< 1.6 kHz Impulsive	201 dB_{peak}	N/A
		186 dB_{RMS}	160 @ 54 m
		176 dB_{SEL}	150 @ 54 m
Hopper Propulsion	< 1 kHz Combination	191 dB_{peak}	N/A
		176 dB_{RMS}	120 @ 5,400 m
		176 dB_{SEL}	150 @ 54 m
Hopper Dredge & Propulsion	< 1.1 kHz Combination	190 dB_{peak}	N/A
		175 dB_{RMS}	120 @ 4,600 m
		175 dB_{SEL}	150 @ 46 m
Tug Propulsion	< 1 kHz Combination	185 dB_{peak}	N/A
		170 dB_{RMS}	120 @ 2,200 m
		170 dB_{SEL}	150 @ 22 m

The loudest project-related source would be the echo-sounders used for hydrographic surveys. However, the 200 kHz operating frequency of the echo-sounders is far above the known hearing ranges of fish. Further, the narrow beam width of the echo-sounder and the movement of the survey vessel suggests that any exposure would be extremely brief, resulting in exposure to a very low number of impulses. Therefore, is highly unlikely that any of the species considered in this Opinion could hear or respond to the sound, and no behavioral disturbance would be caused. Further, although the SL is above the threshold for the onset of injury in fish and low-frequency cetaceans, NMFS knows of no information to suggest that the extremely brief exposure to ultrasonic pulses from echo-sounders would cause any detectable physiological effects on auditory and non-auditory tissues in any of the species considered in this Opinion.

Ambient noise levels at the project locations that comprise the action area are expected to be relatively high, especially the channels in Grays Harbor, Everett Harbor, and the Duwamish Waterway. Typical sources of ambient noise at these sites include high levels of daily vessel traffic that include large oceangoing commercial vessels, tugs, and numerous medium to small commercial and recreational vessels. Keystone Harbor contains a WDOT ferry terminal. Another WDOT ferry terminal is adjacent to Port Townsend Harbor. Ferries cross Admiralty Inlet in route between these two terminals about every hour and a half between 7 AM and 11 PM. Recreational and commercial fishing vessels routinely transit the Swinomish channel. Other sources of ambient noise include waterfront industrial activity, as well as noise related to river flow and tidal movements. Blackwell (2005) suggests that tidal movements can contribute significantly to in-water noise levels. The author reported ambient noise between 10 Hz and 10 kHz in Alaska that were from 95 to over 120 dB in the absence of strong currents, with ambient noise levels of up to 133 dB during strong tidal movements. Reported ambient noise in New York Harbor, between 20 Hz to 20 kHz, ranged from 98 to 129 dB_{RMS}, with an average of 117 dB_{RMS} (Reine *et al.* 2014a). Average ambient noise levels of 117 dB_{RMS} were also reported off the coast of Virginia Beach, while minimum and mean ambient noise levels of about 125 and 134 dB_{RMS}, respectively were reported in the Kennebec River, Maine (Reine *et al.* 2014b). Measured ambient noise between about 16 Hz and 30 kHz in Admiralty Inlet, Puget Sound ranged from 94 to 144 dB, with ambient noise exceeding 100 dB 99% of the time (Bassett *et al*. 2010). Therefore, in-water ambient noise within the action area is likely to routinely exceed 120 dB_{RMS}.

Adult and larval eulachon, as well as adult and sub-adult southern green sturgeon are not likely to be adversely affected by project-related noises in Grays Harbor and in the Quillayute River Navigation Channel. Studies indicate that exposure to elevated noise may cause physiological effects in fish that may include temporary hearing loss (Scholik and Yan 2002), increased stress (Graham and Cooke 2008), and increased vulnerability to predators (Simpson *et al*. 2016). It may also cause behavioral effects such as acoustic masking (Codarin *et al*. 2009), startle responses and altered swimming (Neo *et al*. 2014), and abandonment or avoidance of the area of acoustic effect (Picciulin *et al*. 2010; Mueller 1980; Sebastianutto *et al*. 2011; Xie *et al*. 2008).

As describe above, exposure to impulses from the echo-sounder would cause no detectable effects in either species of fish. The SL of the remaining sources are all below the thresholds for injury in fish, and it is extremely unlikely that individuals of either species would remain close enough to any source to accumulate injurious levels of sound energy. At most, within the area around a source where RL exceeds 150 dB_{SEL}, exposed individuals may experience low levels of behavioral disturbance, including avoidance of that area. In Grays Harbor, the farthest distance to effective quiet would be 177 feet (54 m) around the hopper dredge and the episodic placement of spuds. In the Quillayute River Navigation Channel, the farthest distance would also be 177 feet (54 m) around the episodic placement of spuds, but would otherwise be limited to about 72 feet (22 m) around the tug boat, followed by 33 feet (10 m) around the hydraulic dredge. It is unlikely that any areal avoidance would prevent fish from moving past the source, as in the case of spawning eulachon migrating upstream, nor would it prevent either species from accessing habitat resources that aren't readily available outside of the area of acoustic effect. Therefore, adult and larval eulachon, as well as adult and sub-adult southern green sturgeon would experience only minor effects from exposure to any action-related in-water noise sources.

<u>2.4.1.5 Degraded Water Quality:</u> Exposure to water of degraded quality is likely to adversely affect adult and larval eulachon as well as adult and sub-adult green sturgeon. Degraded water quality would occur through dredging and in-water disposal of sediments. That work will

temporarily increase suspended sediments and may mobilize chemical contaminants. It may also reduce dissolved oxygen levels. The amount of sediments that may be suspended in the water column, as well as the duration and extent of a turbidity plume will depend largely on the composition of the sediments, the method of dredging, and the movement of the water. The finer the sediments, the longer those sediments will remain suspended in the water column. The faster the currents, the greater distance the turbidity plume will extend from the activity. The majority of the material to be dredged by the proposed action is expected to consist of clean sands that would settle out of the water column within minutes.

The use of hydraulic dredges reduces the potential for large turbidity plumes because the suction draws mobilized sediments into the dredge. Conversely, the clamshell buckets used during mechanical dredging are not water tight, and they mobilize sediments across the full depth of the water column as they are pulled through the water. Similarly, in-water disposal of sediments would mobilize sediments across the full depth of the water column. The turbidity plumes from dredging and in-water disposal of sands are expected to be both localized and short-lived. However, mechanical dredging would also occur in some up-river areas and in enclosed boat basin channels and where sediments include higher fractions of silt and other fine-grained materials that once mobilized tend to stay suspended in the water column longer than coarse-grained materials do. The intensity of a turbidity plume is typically measured in Nephlometric Turbidity Units (NTU), which is a measure of opacity caused by the suspended sediments. 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).

Several reports summarized dredged material behavior and sediment resuspension due to hopper and clamshell dredging and associated open water disposal (Havis 1988; Herbich and Brahme 1991; LaSalle et al. 1991; McLellan et al. 1989; Palermo et al. 2009; Truitt 1988). Hopper dredging creates a near-bottom turbidity plume of suspended material from the dragheads and a smaller plume in the upper water column from overflow of turbid water during hopper-filling operations. Turbidity plumes could extend up to 1,200 meters along the bottom from hopper dredges (Clark and Wilbur 2000). Near-bottom sediment plumes at concentrations of up to 891 mg/L were reported for a hopper dredge removing silty clay in Grays Harbor (Hayes *et al.* 1984 in LaSalle *et al*. 1991). However, under the proposed action, the sediment to be hopper-dredged consists primarily of coarse sand with less than 2 percent fines. Similar material dredged in the Columbia River settled out of the water column at 0.03 to 0.06 feet per second. Assuming that the dredge may re-suspend sands up to 6 feet off of the bottom, those sands would settle out of the water in about 2 minutes. Therefore, this action's hopper dredge turbidity plumes would likely be small, short-lived, with low sediment concentrations.

Mechanical dredging in areas containing high levels of fine-grained material, as well as in-water disposal of material from those areas, is likely to exceed the NTU threshold above. The turbidity plumes that are created may extend 200 to 500 feet down-current from the point of dredging or disposal, and may take hours after work has stopped to return to background levels. However, the periodic mobilization of bottom sediments would cause only minor, localized, and short-term impacts on the water column that would not change the overall water quality in the action area. LaSalle (1991) determined that, within about 300 feet of clamshell dredging of fine silt or clay, the expected concentrations of suspended sediment would be about 700 and 1,100 mg/l at the surface and bottom of the water column, respectively. During water quality monitoring around maintenance dredging of inner Grays Harbor with a clamshell dredge, the sediment concentrations exceeded 500 mg/L in only 23 of 600 samples, and seven of the samples were of ambient conditions (Phipps *et al*. 1992 in COE 2011b). The highest reported concentration was 3,000 mg/L with an ambient measurement of 700 mg/L.

In-water disposal of sediments will create a discharge field from the bottom of the ship's hull (hopper dredge or bottom-dump barge) to the bottom of the open water disposal site. However, only about 5 percent of the material may remain temporarily suspended in the water column (Truitt 1988) to create a turbidity plume. Sediments would be identical to the materials described above for hopper and mechanical dredging. Therefore, the concentrations of suspended sediments are expected to be similar. The extent of the plume would be largely influenced by tidal action, currents, and vessel movement. The plume is anticipated to be indistinguishable from background levels no more than a few hours after disposal.

The effects on fish exposed to suspended sediments 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. At concentration levels of about 700 to 1,100 mg/l, minor physiological stress would be expected in juvenile salmon only after about three hours of continuous exposure (Newcombe and Jensen 1996). Adult eulachon sensitivity would likely be similar to that of juvenile salmon, while larval eulachon may be more sensitive. Green sturgeon are relatively tolerant of elevated suspended sediment concentrations. They are typically found in turbid conditions, and they forage by stirring up sediments to access benthic prey such as burrowing shrimp. Further, Wilkens *et al.* (2015) experimentally demonstrated that the closely related Atlantic sturgeon experience no significant effects from three days of continuous exposure to suspended sediment concentrations of up 500 mg/L.

The eulachon that may be exposed to action-related suspended sediments would most likely be moving past the dredging sites. Therefore, the duration of their exposure to turbidity above background levels would likely be measured in minutes, and at most a low number of hours. Therefore, eulachon and salmon would be briefly exposed to sediment concentrations that are expected to elicit no more than low-level behavioral effects such as avoidance of the plume, and temporary minor physiological effects such as gill flaring (coughing), temporarily reduced feeding rates and success, and moderate levels of stress that would not affect the fitness of the exposed individuals. Although green sturgeon exposure to turbidity may exceed that of eulachon and salmon, their tolerance of relatively high levels of suspended sediments suggests that the exposure would not affect their fitness.

Should dredged sediments be contaminated, dredging and disposal will mobilize chemical contaminants into the water column. Common contaminants include metals, pesticides, polychlorinated biphenyls (PCB), polycyclic aromatic hydrocarbons (PAH), phenols, and phthalates. Many of these pollutants can cause impacts on fish that range from avoidance of an area to mortality in the exposed individuals, depending on the pollutant and its concentration (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). To reduce the potential for mobilizing contaminants, the COE conducts sediment sampling and analysis at each of the project sites on a six-year cycle. Sediments found to exceed the Dredged Material Management Program (DMMP) standards are excluded from the proposed action, and would be subject to separate consultation prior to their being removed. However, meeting the DMMP standards does not preclude the dredging of sediments with trace amounts of contaminants. Further, the cycle of sampling and dredging is not always successful in detecting contamination prior to a dredging event. On rare occasions, sampling done shortly following dredging has indicated that the dredged sediments were likely to have exceeded DMMP standards. Therefore, the proposed action may adversely affect eulachon and green sturgeon that are exposed to the episodic resuspension of trace levels of contaminants, and on rare occasions, by the resuspension of contaminants at concentrations that exceed DMMP standards. However, the overwhelming majority of the sediments that would be dredged as part of this action are expected to be free of contamination, and the presence of any detectable levels of contaminants of concern in the water column are expected to be so infrequent, localized, and short-lived, that any impacts that may occur in exposed individuals would cause no population-level effects for any of the species considered in this Opinion.

Estuarine sediments are often anaerobic and may cause an oxygen demand that can decrease dissolved oxygen (DO) levels when suspended in the water column (Hicks *et al*., 1991; Morton 1976). The impact on DO is a function of the oxygen demand of the sediment, the amount of material suspended in the water, the duration of suspension, and the water temperature (Lunz and LaSalle 1986; Lunz *et al*. 1988), and tend to be most severe lower in the water column (LaSalle 1988). Adequate tidal flushing and other mechanisms that mix the water act to return DO to ambient levels. Reduced DO has been shown to affect swimming performance in salmonids (Bjornn and Reiser 1991). Reduced swimming performance could reduce an affected fish's ability to forage, and to escape predation. Salmon avoidance reactions have been observed when DO levels dropped below 5.5 mg/l (Hicks 1999), which could drive fish from preferred forage areas, or may drive them away from shelter and thereby increase the risk of predation.

Most of the Grays Harbor and Quillayute River Navigation Channels would be dredged annually or bi-annually, with two small sections of the Grays Harbor channel near Aberdeen being dredge every 5 years. The frequency of dredging in these channels suggests that the accumulation of anaerobic sediments would be very limited. The low expected levels of oxygen demand, combined with the high rates of river flow and tidal exchange in these channels support the understanding that any reduction in DO would be very small and short-lived, and unlikely to cause detectable effects on the behaviors or fitness of any eulachon or sturgeon that may be exposed. The 10-year periodicity of dredging in Westhaven Cove may allow for accumulation of anaerobic sediments. Further, much of the channel is enclosed, with limited water exchange. It is possible that green sturgeon and larval eulachon could be exposed to cove waters with reduced DO. The effects of this exposure are uncertain, but may include reduced swimming and foraging and possibly avoidance of the area for green sturgeon. Larval eulachon that remain in areas with reduced DO may experience more serious effects, such as reduced growth, increased risk of predation, and direct mortality. However, the number of exposed individuals for either species is expected to be too low to cause population effects should they be injured or killed due to the exposure.

The water quality monitoring plan (WQMP) for this action is intended to limit turbidity plumes to 600 feet in Grays Harbor and 300 feet in all other channels. It also requires that dredging and/or in-water sediment disposal operations halt if turbidity exceeds 1,200 or 600 feet, respectively (Appendix 2). The COE has committed to comply with those standards. Therefore the extent of detectable water quality impacts from dredging and/or in-water sediment disposal are not expected to exceed those ranges.

<u>2.4.1.6 Altered Benthic Habitat:</u> Alteration of benthic habitats is likely to adversely affect adult and sub-adult green sturgeon, but would cause minor effects in adult and larval eulachon. Dredging and in-water disposal of sediments alters benthic habitats. It reduces the abundance of infaunal and epifaunal invertebrate organisms and submerged aquatic vegetation (SAV). It also alters the population structure of benthic organisms within the affected area, and simplifies the character of the substrate. Repeated dredging of an area maintains reduced abundance and altered population structures as compared to what would occur in the absence of dredging.

Eulachon and juvenile salmon prey on planktonic organisms such as copepods and euphausiids, as well as on the larvae of many benthic species and fish (NMFS 2006a). Green sturgeon typically feed on benthic invertebrates such as crustaceans and mollusks, with burrowing shrimp being a major component of their diet (Moyle *et al*. 1992; NMFS 2015b). Armstrong *et al*. (1981) reported the removal of crabs, shrimp, bivalves, and several fish species during entrainment studies in Grays Harbor. Dredging also removes SAV (i.e. macro algae and eelgrass) from the affected areas. SAV provides important structural environments that form the base of detrital-based food webs that are a source of secondary production by supporting epiphytic plants, animals, and microbial organisms that in turn are grazed upon by other invertebrates and by larval and juvenile fish (NMFS 1997). The loss of SAV reduces primary production, and removes habitat that contributes to trophic systems, which in turn may reduce prey availability for eulachon, green sturgeon, and salmon. The loss of SAV also reduces available structural habitat that small fish may use to avoid predators. Disposal of dredged sediments at the Grays Harbor in-water disposal sites will bury benthic organisms and SAV.

The available information to describe ecosystem responses to repeated dredging is limited, but indicates that little post-dredging recovery would occur during the first seven months after dredging, after which early successional fauna would begin to dominate over the next six months (Jones and Stokes 1998). This suggests that full recovery of a site may take years, and that periodic maintenance dredging of the navigation channels will likely maintain habitats at lower functional levels with altered and reduced population structures compared to undisturbed areas. Therefore, continued maintenance dredging and sediment disposal is likely to prevent full recovery of the affected areas. However, this also means that continued maintenance dredging would occur in altered habitats that are already functioning at reduced levels. Consequently, the number and diversity of the benthic organisms that would be removed by dredging are likely quite low, especially in areas that are dredged frequently (annually to bi-annually). Similarly, we expect that the amount of SAV likely to be affected by maintenance dredging, and the corollary effects on prey availability, will be small. The rate and degree of recovery in the in-water areas is also uncertain. However, the disposal sites are located in dynamic, relatively high energy areas that are frequently exposed to strong currents and large oceanic waves. Therefore the ecosystems in these areas are expected to be highly adapted to frequent disturbance, and likely to recover relatively quickly.

The proposed maintenance dredging and in-water sediment disposal in around Grays Harbor, as well as the maintenance dredging in the Quillayute River would temporarily reduce or eliminate benthic organisms within the affected areas, and over the long term, would maintain reduced and altered benthic populations in the affected areas as compared to undisturbed areas. The small size of the affected areas as compared to the rest of the benthic habitat at these sites, combined with the high levels of water mixing, suggest that any reduction in the availability of planktonic prey for eulachon would be undetectable. Conversely, because the Grays Harbor navigation channels are the areas of the bay that green sturgeon are most likely to hold in during the day, and because those fish forage while holding in deep channels and pools, the reduced prey availability in the channels may cause fitness impacts such as reduced growth. However, because the size of the affected area is very small compared to the rest of Grays Harbor, it is likely that the vast majority of green sturgeon forage habitat would be unaffected by the proposed action. Therefore, dredging-related prey reduction is unlikely to injure or kill any green sturgeon.

<u>2.4.1.7 Critical Habitat:</u> The planned dredging and sediment disposal is likely to adversely affect CH that has been designated for southern green sturgeon in Grays Harbor. As discussed below in section 2.11.1, the proposed work at these three sites is not likely to adversely affect designated critical habitat for leatherback sea turtles. The expected effects on southern green sturgeon critical habitat from completion of the proposed action, including full application of the conservation measures and BMPs, would be limited to the impacts on the PBF of coastal bays and estuaries and coastal marine areas as described below. This assessment considers the intensity of expected effects in terms of the change they would cause in affected PBF 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.

1. <u>Freshwater riverine and delta system</u> – Does not occur in the action area.
2. <u>Coastal bays and estuaries</u>
   a. Food resources – Continued maintenance dredging and sediment disposal will cause long-term moderate effects on food resources in that it would periodically remove benthic organisms and maintain previously altered habitats at reduced levels of prey abundance and altered populations as compared to undisturbed areas. Although the affected areas constitute small part to the total available forage habitat in the bay, the impact would occur in an area believed to be important to green sturgeon. Therefore, the effect on this PBF's ability to support green sturgeon is considered moderate, but unlikely to change the quality and function of this PBF.
   b. Migratory corridor – The proposed work may cause ephemeral minor avoidance of the area around ongoing work due to elevated noise, activity, and reduced water quality. Because the affected areas would be very small and would not prevent movement around the work area, the action would cause no meaningful effect on this PBF's ability to support migration of green sturgeon within and around Grays Harbor. Therefore, the action would cause no change in the quality and function of this PBF.

c. Sediment quality – Continued maintenance dredging and sediment disposal would cause ephemeral minor effects on sediment quality. The overwhelming majority of the sediments that would be dredged as part of this action are expected to be free of contamination, and the presence of any detectable levels of contaminants of concern in the sediments are expected to be so infrequent, localized, and short-lived, that it would cause no detectable effect on this PBF's ability to support green sturgeon, and will not change the quality and function of this PBF.
d. Water flow – The amount of water taken up during dredging is virtually undetectable against the water volumes in the affected water bodies, and the water is quickly returned to the system during sediment disposal. Therefore, it will not affect this PBF's ability to support green sturgeon, and will not change the quality and function of this PBF.
e. Water depth – Continued sediment disposal may cause short-term minor effects on water depth. Dredging would maintain the existing channels close to prescribed depths that range between 32 and 46 feet in the Grays Harbor Channel, and 14 feet in Westhaven Cove. Because this PBF is concerned with ensuring that water does not become too shallow, dredging supports the PBF. Sediment disposal may cause short-term minor reductions in bottom depth, but would cause no detectable effect on this PBF's ability to support green sturgeon, and will not change the quality and function of this PBF.
f. Water quality – Continued maintenance dredging and sediment disposal will cause episodic ephemeral effects on water quality. It would cause no measurable changes in water temperature and salinity, but would periodically mobilize contaminants and suspended sediments into the water column, and may also periodically reduce DO. Detectable effects on water quality is expected to be limited to the area within 1,200 feet of hopper dredging in Grays Harbor, and 600 feet for all other related activities. Effects are not expected to persist past several hours following the cessation of dredging, so the action would cause no long-term change in the quality and function of this PBF.

3. Coastal marine areas
   a. Food resources – Same as above.
   b. Migratory corridor – Same as above.
   c. Water quality – Same as above.

2.4.2 Port Townsend Harbor, Keystone Harbor, and Swinomish Navigation Channels

Port Townsend Harbor, Keystone Harbor, and Swinomish Navigation Channels are all located within mostly marine waters of the Puget Sound. PS Chinook salmon and PS steelhead inhabit estuarine and marine waters in or near these three project sites. HCSR chum salmon, PS/GB bocaccio, PS/GB yelloweye rock fish, and Southern Resident (SR) killer whales may also be present near these sites. Designated critical habitat for PS Chinook salmon, PS/GB bocaccio, and SR killer whales is present at all three of these sites, and designated critical habitat for HCSR chum salmon is present at Port Townsend Harbor. As discussed below in section 2.11.2, the proposed work at all three of these sites will have no meaningful impact on HCSR chum salmon, PS/GB bocaccio, PS/GB yelloweye rock fish, and SR killer whales. It will also have no meaningful impact on designated critical habitat for PS/GB yelloweye rockfish and SR killer whales.

Some PS Chinook reside in the Puget Sound year-round, but are most plentiful when ocean-going adults return to spawn, typically mid-June through November, and when smolts enter marine waters between early-March and mid-July. The timing of PS steelhead spawning runs suggests that adults may be present year-round. Most PS steelhead smolt outmigration occurs April through June. However, unlike Chinook salmon, steelhead smolts head to sea quickly, and do not remain long in nearshore marine waters. No salmon spawning has been documented or is likely to occur in or upstream from any of these three sites. No notable habitat resources for ESA-listed fish are present in Port Townsend and Keystone Harbors, but the Swinomish channel occasionally serves as a migration corridor for low numbers of salmon, and may also provide limited rearing resources for juvenile PS Chinook salmon.

As described in Section 1.3 (Proposed Action), every 8 to 10 years, contractors would conduct about 45 days of clamshell dredging between July 16 and February 15 at Port Townsend Harbor. The dredged material would be disposed of via bottom dump barge to the DMMP-managed Port Townsend open-water dispersive disposal site. At Keystone Harbor, contractors would conduct about 120 days of clamshell or hydraulic dredging every 5 years between July 16 and February 15. Dredged sediments would be deposited via bucket crane or hydraulic pipeline to a designated beach disposal site. In the Swinomish channel, contractors would conduct about 150 days of clamshell dredging every 2 to 7 years between July 16 and February 15. The dredged material would be disposed of via bottom dump barge to the DMMP-managed Rosario Strait dispersive site or the Port Gardner disposal site. A described above at section 1.3, sediment disposal at the DMMP-managed in-water disposal sites is covered under a programmatic consultation (NMFS 2015a) and is therefore not considered a part of the proposed action.

Because temporal and spatial overlap may exist between the proposed dredging activities and the possible presence of PS Chinook salmon and PS steelhead, the proposed action may affect those fish through exposure to: (1) Entrainment; (2) Bucket strike; (3) Vessel collision; (4) Elevated noise; (5) Degraded water quality; and (6) Altered benthic habitat.

2.4.2.1 Entrainment: Entrainment of PS Chinook salmon and PS steelhead during mechanical and hydraulic dredging in Port Townsend Harbor, Keystone Harbor, and Swinomish Navigation Channels is highly unlikely. Entrainment is described above at 2.4.1.1. Hydraulic dredging, which would pose the greatest risk of entrainment, would only be done at Keystone Harbor. Dredging at the other two sites is limited to mechanical dredging with a clamshell bucket. Keystone Harbor is over 10 miles away from the closest salmon spawning stream, and separated by the deep water of Admiralty Inlet. The harbor is very small, supports no notable salmon-supporting habitat features, and large automobile ferries enter and leave the harbor many times a day. Therefore, very few salmon are likely to enter the harbor, and those that do are likely to quickly leave due to the high level of disturbance caused by the ferry. Further, dredging would occur during the COE in-water work window for marine waters, which is timed to avoid out-migrating juvenile salmonids. As described above at 2.4.1.1, entrainment of fish in a clamshell buckets is very rare, even in areas with high numbers of fish. Because the numbers of salmon that may enter any of these three harbors is expected to be very low, especially during the work window, and because salmon are very agile and likely to avoid the dredge, it is highly unlikely that any would be entrained during clamshell dredging at these sites.

2.4.2.2 Bucket Strike: For the reasons expressed above under entrainment at 2.4.1.1 and 2.4.2.1, the risk of PS Chinook salmon and PS steelhead being struck by a clamshell bucket during mechanical dredging is highly unlikely.

2.4.2.3 Vessel Collision: The risk of collision between dredge-related vessels and PS Chinook salmon and PS steelhead is highly unlikely. Unlike marine mammals and sea turtles, salmon and steelhead do not go to the surface to breathe. Further, both species are capable of detecting the vessel, and are capable of high-speed swimming that would be more than adequate to avoid collision with the vessel. Should PS Chinook salmon and PS steelhead be close to the surface along the path of a moving dredge-related vessel, NMFS expects that exposed individuals would respond by quickly swimming down and away from the perceived threat, and therefore avoid collision.

2.4.2.4 Elevated Noise: Exposure to elevated noise would cause minor effects in PS Chinook salmon and PS steelhead. As described above at 2.4.1.4, exposure to impulses from the echo-sounder would cause no detectable effects in any of the species considered in this Opinion. The SL of the remaining sources are all below the thresholds for injury, and it is extremely unlikely that individuals of either species would remain close enough to any source to accumulated injurious levels of sound energy. At most, within the area around a source where RL exceeds 150 dB_{SEL}, exposed individuals may experience low levels of behavioral disturbance, including avoidance of that area. In all of these harbors, the farthest distance to effective quiet would be 177 feet (54 m) around the episodic placement of spuds, but would otherwise be limited to about 72 feet (22 m) around the tug boat, followed by 33 feet (10 m) around the hydraulic dredge. It is unlikely that any areal avoidance would prevent fish from moving past the source or from accessing desirable habitat resources.

2.4.2.5 Degraded Water Quality: Exposure to water of degraded quality is likely to adversely affect PS Chinook salmon and PS steelhead. As described above at 2.4.1.5, dredging will temporarily increase suspended sediments and may mobilize chemical contaminants. It may also reduce dissolved oxygen levels. The amount of sediments that may be suspended in the water column, as well as the duration and extent of a turbidity plume will depend largely on the composition of the sediments, the method of dredging, and the movement of the water. The finer the sediments, the longer those sediments will remain suspended in the water column. The faster the currents, the greater distance the turbidity plume will extend from the activity. The majority of the material to be dredged by the proposed action is expected to consist of clean sands that would settle out of the water column within minutes, especially at Keystone, which has good water exchange and is dredged regularly.

Mechanical dredging in Port Townsend Harbor and in the Swinomish Channel may create turbidity plumes with sediment concentrations of up to about 700 and 1,100 mg/l at the surface and bottom of the water column, respectively. Those plumes could extend 200 to 500 feet down-current from the point of dredging, and take hours to return to background levels after work has stopped. Suspended sediment concentrations from dredging in Keystone Harbor will likely be much lower than at the other two sites because regular ferry traffic in the harbor limits the accumulation of fine particulates, and the harbor is dredged much more frequently than the other two sites. The periodic mobilization of bottom sediments at these sites would cause only minor, localized, and short-term impacts on the water column that would not change the overall water quality in the action area. Juvenile salmon that were exposed to suspended sediment concentration levels of about 700 to 1,100 mg/l demonstrated minor physiological stress only after about three hours of continuous exposure (Newcombe and Jensen 1996). The salmon that may be exposed to dredging-related suspended sediments at these sites would most likely be adults that are moving past the area. Therefore, the duration of their exposure to elevated turbidity would likely be measured in minutes, and at most a low number of hours. Therefore, salmon would be only briefly exposed to sediment concentration that are expected to elicit no more than low-level behavioral effects such as avoidance of the plume, and temporary minor physiological effects such as gill flaring (coughing), temporarily reduced feeding rates and success, and moderate levels of stress that would not affect the fitness of the exposed individuals.

As described above at 2.4.1.5, the bottom sediments in these navigation channels are analyzed for contaminants every six years. Although sediments found to exceed DMMP standards would not be dredged under the proposed action, the standards do allow for dredging of sediments with trace amounts of some contaminants. Further, on rare occasions, sampling done shortly after a dredging event has indicated that the dredged sediments were likely to have exceeded DMMP standards. Therefore, the proposed action may adversely affect adult PS Chinook salmon and PS steelhead that are exposed to the episodic resuspension of trace levels of contaminants, and on rare occasions, by the resuspension of contaminants at concentrations that exceed DMMP standards. Because the harbors at Port Townsend and Keystone are highly enclosed, and spatially separated from salmon spawning streams, it is highly unlikely that adult PS Chinook salmon and PS steelhead would approach close enough to either of these harbors to be exposed to detectable levels of dredge-related contaminants.

Adult PS Chinook salmon and PS steelhead adults that migrate through the Swinomish channel may be present during dredging. The overwhelming majority of the sediments that would be dredged as part of this action are expected to be free of contamination, and the presence of any detectable levels of contaminants of concern in the water column are expected to be infrequent. However, it is likely that at least some individuals of these species may be briefly exposed to detectable levels of contaminated sediments within the Swinomish channel over 25 years of dredging. The numbers of adults that may exposed annually to dredging-related contaminants is unquantifiable with any degree of certainty. However, the numbers are expected to be very low based on the expectation that very few salmonids migrate through Swinomish Channel, and that temporal and spatial overlap of fish presence with that of mobilized contaminants would be very limited due to the brief and relatively random occurrence of either event. The likelihood of exposure would be further reduced by the measures taken by the COE to reduce the likelihood and extent of contaminant mobilization, and on the expectation that returning adults are likely to avoid the noise and activity caused by the dredging, and may also attempt to avoid the turbidity plume. The effects of these brief episodic exposures on adult PS Chinook salmon or PS steelhead are uncertain, but are not expected to result in injury to individual fish. This expectation is supported by a recent Opinion for similar dredging in salmon rearing and migratory habitat (NMFS 2017b), which determined that the effects of exposure to chemical contaminants on salmon and green sturgeon would be minor and not result in injury. Although it is possible that exposure may impact the reproductive success in some exposed individuals, the intensity of this effect on individual fish is again unknown and unquantifiable with any degree of certainty, but is expected to be minor at the level of the individual, and undetectable at population levels.

Mobilization of anaerobic sediments into the water column may cause an oxygen demand that can decrease dissolved oxygen (DO) levels (Hicks *et al*., 1991; Morton 1976). Reduced DO can affect swimming performance in salmonids (Bjornn and Reiser 1991). Reduced swimming performance could reduce an affected fish's ability to forage, and to escape predation. Salmon avoidance reactions have been observed when DO levels dropped below 5.5 mg/l (Hicks 1999), which could drive fish from preferred forage areas, or may drive them away from shelter and thereby increase the risk of predation. The location and frequency of dredging in Keystone Harbor suggests that the accumulation of anaerobic sediments is unlikely. The locations and periodicity of dredging in Port Townsend Harbor and in the Swinomish channel may allow for accumulation of anaerobic sediments. It is possible that adult PS Chinook salmon and PS steelhead could be exposed to waters with reduced DO in or near these channels. The exact effects of this exposure are uncertain, but the most likely effect would be temporary avoidance of the area with no detectable effects on the fitness of an exposed individual.

The WQMP for this action is intended to limit turbidity plumes to 300 feet in these channels. It also requires that dredging and/or in-water sediment disposal operations halt if turbidity exceeds 600 feet (Appendix 2). The COE has committed to comply with those standards. Therefore the extent of detectable water quality impacts from dredging and/or in-water sediment disposal are not expected to exceed that range.

<u>2.4.2.6 Altered Benthic Habitat:</u> Alteration of benthic habitats would cause minor effects in PS Chinook salmon and PS steelhead. As described above at 2.4.1.6, dredging alters benthic habitats and reduces the abundance of infaunal and epifaunal invertebrate organisms and submerged aquatic vegetation (SAV). It also alters the population structure of benthic organisms within the affected area, and simplifies the character of the substrate. Repeated dredging of an area acts to maintain reduced abundance and altered population structures as compared to what would occur in the absence of dredging. Therefore, the proposed maintenance dredging of the Port Townsend Harbor, Keystone Harbor, and Swinomish Navigation Channels would temporarily reduce or eliminate benthic organisms within the affected areas, and over the long term, would maintain reduced and altered benthic populations in the affected areas as compared to undisturbed areas. Because juvenile salmon prey on planktonic organisms such as the larvae of many benthic species, as well larval fish, copepods, and euphausiids (NMFS 2006a), the proposed action would reduce the availability of planktonic prey for juvenile salmonids. However, the small size of the affected areas as compared to the rest of the benthic habitat near these sites, combined with the high levels of water mixing, suggest that any reduction in the availability of planktonic prey for juvenile salmonids would be undetectable.

The removal of SAV in Keystone Harbor and the Swinomish channel may reduce the availability of natural cover for juvenile salmon that may enter those areas. However, the affected areas are a small part to the total available SAV-supporting substrate in and near those channels, and the abundance of SAV within the channels is limited due to previous dredging. Additionally, the dredging would only remove SAV from the channels, near the center of the affected water bodies. It would not affect SAV in the shallower areas along the sides of the channels that are more likely to be used by juvenile salmon. Juvenile salmon are very unlikely to enter Port Townsend Harbor where they could be affected by removal of SAV from that channel. Therefore, the effects on juvenile salmon from the reduced availability of cover through dredging-related removal of SAV are likely to be undetectable. Adult PS Chinook salmon and PS steelhead neither prey on planktonic larvae, nor do they utilize SAV for cover. Therefore, they would be unaffected by the expected alterations of benthic habitat.

2.4.2.7 Critical Habitat: The planned dredging is likely to adversely affect critical habitat that has been designated for PS Chinook salmon at all three sites; for HCSR chum salmon in Port Townsend Harbor; and for PS/GB bocaccio in Port Townsend Harbor and Keystone Harbor. As discussed below in section 2.11.1, the proposed work at these three sites is not likely to adversely affect designated critical habitat for PS/GB yelloweye rockfish and SR killer whales.

The essential PBF of PS Chinook salmon and HCSR chum salmon critical habitat is listed below. This assessment considers the intensity of expected effects in terms of the change they would cause in affected PBF 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 expected effects on designated critical habitat for PS Chinook salmon and for HCSR chum salmon from completion of the proposed action, including full application of the conservation measures and BMP, would be limited to the impacts on the PBF of nearshore marine areas free of obstruction and excessive predation as described below. Nearshore marine areas were not designated as critical habitat for PS steelhead.

1. Freshwater spawning sites – Does not occur in the action area.
2. Freshwater rearing sites – Does not occur in the action area.
3. Freshwater migration corridors – Does not occur in the action area.
4. Estuarine areas – Does not occur in the action area.
5. Nearshore marine areas free of obstruction and excessive predation
    a. Free of obstruction and excessive predation – Continued maintenance dredging of the Swinomish channel is likely to cause episodic ephemeral avoidance of the area around ongoing dredging due to elevated noise, activity, and reduced water quality. This effect may periodically delay low numbers of adult PS Chinook salmon that may migrate through the channel. No obstruction is expected at Port Townsend or Keystone Harbors. The work would cause no change in the abundance of predators, nor would it cause conditions that would improve the success of predators. PS Chinook salmon use of the Swinomish Channel as a migration corridor is very low, and the action is expected to cause no change in the quality and function of this PBF. However, the proposed action would act to maintain this PBF at a reduced functional level.
    b. Forage – Continued maintenance dredging will cause long-term minor effects on food resources in that it would periodically remove benthic organisms and maintain previously altered habitats at reduced levels of prey abundance and altered populations as compared to undisturbed areas. However, the affected areas are very small parts to the total available forage-producing substrate in the areas near the channels. The small reduction

of available larvae would be undetectable due to the high levels of mixing of the affected waters with the vastly larger volume of unaffected water. Therefore, the action would cause no detectable effect on this PBF's ability to support PS Chinook salmon and HCSR chum salmon, and no change in the quality and function of this PBF.

c. Natural Cover – Continued maintenance dredging of the Keystone and Swinomish channels will cause long-term minor effects on natural cover in that it would periodically remove SAV, and maintain previously altered habitats at reduced levels of SAV as compared to undisturbed areas. However, the affected areas are a small part to the total available SAV-supporting substrate in and near the channels, and the dredging will occur near the center of the channels where the water is deepest. Further, the dredging would not affect SAV in the shallower areas along the sides of the channels that are more likely to be used by the low numbers of juvenile salmon that may migrate past those sites. Juvenile salmon are very unlikely to enter Port Townsend Harbor where they could be affected by removal of SAV from that channel. Therefore, the action would cause no meaningful effect on this PBF's ability to support PS Chinook salmon and HCSR chum salmon, and no change in the quality and function of this PBF.

d. Water quantity – Continued maintenance dredging will cause no detectable effect on water quantity. The amount of water taken up during dredging is virtually indistinguishable against the water volumes in the affected water bodies, and the water is quickly returned to the system during sediment disposal. Therefore, the action would cause no detectable effect on this PBF's ability to support PS Chinook salmon and HCSR chum salmon, and no change in the quality and function of this PBF.

e. Water quality – Continued maintenance dredging will cause episodic ephemeral effects on water quality. It would cause no measurable changes in water temperature and salinity, but would periodically mobilize contaminants and suspended sediments into the water column, and may also periodically reduce DO in the water column. Detectable effects on water quality is expected to be limited to the area within 600 feet of dredging, and are not expected to persist past several hours following the cessation of dredging. Therefore the action would cause no long-term change in the quality and function of this PBF.

6. <u>Offshore marine areas</u> – Does not occur in the action area.

The expected effects on PS/GB bocaccio 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 nearshore juvenile settlement habitats PBF as described below. Designated critical habitat for PS/GB yelloweye rockfish is limited to deep water areas that are outside of the range of expected effects from the proposed action. Therefore, it is highly unlikely that the action would cause any impacts on the PBF of that critical habitat.

The expected effects on PS/GB bocaccio CH from completion of the proposed action, including full application of the conservation measures and BMP, would be limited to the impacts on the nearshore juvenile settlement habitats PBF as described below.

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 – Continued maintenance dredging will cause long-term minor effects on food resources in that it would periodically remove benthic organisms and maintain previously altered habitats at reduced levels of prey abundance and altered populations as compared to undisturbed areas. However, the affected areas are spatially separated from bocaccio-supporting habitats, and are very small parts to the available forage-producing substrate in the areas near the channels. Further, any reduction in available larvae would be small and undetectable due to the high levels of mixing of the affected waters with the vastly larger volume of unaffected water. Therefore, the action would cause no detectable effect on this PBF's ability to support PS/GB bocaccio, and no change in the quality and function of this PBF.
   b. Water quality – Continued maintenance dredging will cause episodic ephemeral effects on water quality. It would cause no measurable changes in water temperature and salinity, but would periodically mobilize contaminants and suspended sediments into the water column, and may also periodically reduce DO in the water column. Detectable effects on water quality is expected to be limited to the area within 600 feet of dredging, and are not expected to persist past several hours following the cessation of dredging. Therefore the action would cause no long-term change in the quality and function of this PBF.
2. Benthic habitats and sites deeper than 98 feet (30 m) – Does not occur in the action area.

2.4.3 Everett Harbor/Snohomish River and Upper Duwamish Waterway Navigation Channels

The Everett Harbor and Snohomish River Navigation Channel (Snohomish Channel) and the Upper Duwamish Waterway are both located within riverine to estuarine waters of the Puget Sound. PS Chinook salmon and PS steelhead utilize both of these project sites. Critical habitat has been designated for PS Chinook salmon and PS steelhead at both of these sites. Critical Habitat for SR killer whales overlaps slightly with the southern end of the Snohomish Channel as well. As discussed below in Section 2.11.3, the proposed work at these two sites will have no meaningful impact on Hood Canal Summer-run chum salmon, PS/GB bocaccio, PS/GB yelloweye rock fish, and SR killer whales. It will also have no meaningful impact on designated critical habitat for PS/GB bocaccio, PS/GB yelloweye rockfish, and SR killer whales. Adult PS Chinook typically enter these channels when they return to freshwater between mid-June and November. Chinook smolts are likely to be present between early-March and mid-July as they migrate to marine waters. Returning adult PS steelhead may be present year-round, whereas steelhead smolt outmigration typically occurs April through June, but they may be present year-round in both river systems.

As described in Section 1.3 (Proposed Action), contractors would annually conduct 60 to 120 days of clamshell or hydraulic pipeline dredging between October 16 and February 14 in the Snohomish Channel. The dredged material would be disposed of via bottom dump barge to the DMMP-managed Port Gardner open-water disposal site, as well as at three beneficial use disposal sites: Jetty Island, Riverside, and Site "O" (Figure 15). In the Upper Duwamish Waterway, contractors would conduct about 45 days of clamshell dredging every 1 to 3 years between October 1 and February 15. Dredged sediments would be deposited via bottom dump barge to the DMMP-managed Elliott Bay open-water non-dispersive disposal site. A described above at section 1.3, sediment disposal at the DMMP-managed in-water disposal sites is covered under a programmatic consultation (NMFS 2015a) and is therefore not considered a part of the proposed action.

Because temporal and spatial overlap may exist between the proposed dredging-related activities and the possible presence of PS Chinook salmon and PS steelhead, the proposed action may affect those fish through exposure to: (1) Entrainment; (2) Bucket strike; (3) Vessel collision; (4) Elevated noise; (5) Degraded water quality; and (6) Altered benthic habitat.

2.4.3.1 Entrainment: Entrainment of PS Chinook salmon and PS steelhead during mechanical and hydraulic dredging in the Snohomish Channel and the Upper Duwamish Waterway is highly unlikely. It is highly unlikely that juvenile PS Chinook salmon would be exposed to the dredging, and therefore extremely unlikely to be entrained by either form of dredging. Some adult PS Chinook salmon may be present during the dredging in these channels. However, as described above at 2.4.1.1, entrainment of fish in a clamshell buckets is very rare, even in areas with high numbers of fish. Additionally, the mobility of adult PS Chinook salmon and their likelihood to avoid the work make it extremely unlikely that they would be entrained in the hydraulic dredge. Adult and juvenile PS steelhead may be present year-round in both channels. As with Chinook, the mobility of adult PS steelhead and the likelihood of avoidance of the ongoing work make their entrainment extremely unlikely. The dredging window is well outside of the peak outmigration season for steelhead smolt, and very few juveniles are likely to reside in areas adjacent to the channels that will be dredged. Further, juveniles that reside in the river are likely to remain in shallow areas along the banks of the rivers, whereas the dredging would be close to the center of the rivers. Therefore it is extremely unlikely that juvenile steelhead would be close enough to ongoing dredging to become entrained.

2.4.3.2 Bucket Strike: For the reasons expressed above under entrainment at 2.4.1.1 and 2.4.3.1, the risk of PS Chinook salmon and PS steelhead being struck by a clamshell bucket during mechanical dredging is highly unlikely.

2.4.3.3 Vessel Collision: The risk of collision between dredge-related vessels and PS Chinook salmon and PS steelhead is highly unlikely. Unlike marine mammals and sea turtles, salmon and steelhead need not go to the surface to breathe. Further, both species are capable of detecting the vessel, and are capable of high-speed swimming that would be more than adequate to avoid collision with the vessel. Should PS Chinook salmon and PS steelhead be close to the surface along the path of a moving dredge-related vessel, NMFS expects that exposed individuals would respond by quickly swimming down and away from the perceived threat, and therefore avoid collision.

2.4.3.4 Elevated Noise: Exposure to elevated noise would cause minor effects in PS Chinook salmon and PS steelhead. As described above at 2.4.1.4, exposure to impulses from the echo-sounder would cause no detectable effects in any of the species considered in this Opinion. The SL of the remaining sources are all below the thresholds for injury, and it is extremely unlikely that individuals of either species would remain close enough to any source to accumulated injurious levels of sound energy. At most, within the area around a source where RL exceeds 150 dB_{SEL}, exposed individuals may experience low levels of behavioral disturbance, including avoidance of area, with no impact on the fitness of the exposed individual. In both of the channels, the farthest distance to effective quiet would be 177 feet (54 m) around the episodic placement of spuds, but would otherwise be limited to about 72 feet (22 m) around the tug boat, followed by 46 feet (14 m) around the bucket dredge and 33 feet (10 m) around the hydraulic dredge. Because both rivers are greater than 300 feet wide in the project areas, it is unlikely that areal avoidance would prevent fish from moving past the work or from accessing desirable habitat resources, including reaching upstream spawning areas.

<u>2.4.3.5 Degraded Water Quality:</u> Exposure to water of degraded quality is likely to adversely affect PS Chinook salmon and PS steelhead. As described above at 2.4.1.5, dredging will temporarily increase suspended sediments and may mobilize chemical contaminants. It may also reduce dissolved oxygen levels. The amount of sediments that may be suspended in the water column, as well as the duration and extent of a turbidity plume will depend largely on the composition of the sediments, the method of dredging, and the movement of the water. The finer the sediments, the longer those sediments will remain suspended in the water column. The faster the currents, the greater distance the turbidity plume will extend from the activity. The majority of the material to be dredged by the proposed action is expected to consist of clean sands that would settle out of the water column within minutes.

In areas with fine silts, dredging in either of these channels may create turbidity plumes with sediment concentrations of up to about 700 and 1,100 mg/l at the surface and bottom of the water column, respectively. Those plumes could extend 200 to 500 feet down-current from the point of dredging, and take hours to return to background levels after work has stopped. The periodic mobilization of bottom sediments at these sites would cause only minor, localized, and short-term impacts on the water column that would not change the overall water quality in the action area. Juvenile salmon that were exposed to suspended sediment concentration levels of about 700 to 1,100 mg/l demonstrated minor physiological stress only after about three hours of continuous exposure (Newcombe and Jensen 1996). The salmon that may be exposed to dredging-related suspended sediments at these sites would most likely be adults that are moving past the area. Therefore, the duration of their exposure to elevated turbidity would likely be measured in minutes, and at most a low number of hours. Therefore, salmon would be only briefly exposed to sediment concentration that are expected to elicit no more than low-level behavioral effects such as avoidance of the plume, and temporary minor physiological effects such as gill flaring (coughing), temporarily reduced feeding rates and success, and moderate levels of stress that would not affect the fitness of the exposed individuals.

As described above at 2.4.1.5, the bottom sediments in these navigation channels are analyzed for contaminants every six years. Although sediments found to exceed DMMP standards would not be dredged under the proposed action, the standards do allow for dredging of sediments with trace amounts of some contaminants. Further, on rare occasions, sampling done shortly after a dredging event has indicated that the dredged sediments were likely to have exceeded DMMP standards. Therefore, over 25 years of dredging in these channels, it is likely that at least some adult PS Chinook salmon and PS steelhead may be briefly exposed to low, but detectable, concentrations of contaminated sediments. The numbers of individual fish that may exposed annually to dredging-related contaminants is unquantifiable with any degree of certainty. However, the numbers are expected to be very low based on the expectation that the temporal and spatial overlap of fish presence with that of mobilized contaminants would be very limited due to the brief and relatively random occurrence of either event. The likelihood of exposure would be further reduced by the measures taken by the COE to reduce the likelihood and extent of contaminant mobilization, and on the expectation that returning adults are likely to avoid the noise and activity caused by the dredging, and may also attempt to avoid the turbidity plume. The effects of these brief episodic exposures on adult PS Chinook salmon or PS steelhead are uncertain, but are not expected to result in injury to individual fish. However, it is possible that exposure may impact the reproductive success in some exposed individuals. The exact effects on reproductive success for individual fish is again unknown and unquantifiable with any degree of certainty, but are expected to be minor at the level of the individual, and undetectable at population levels.

Mobilization of anaerobic sediments into the water column may cause an oxygen demand that can decrease dissolved oxygen (DO) levels (Hicks *et al*., 1991; Morton 1976). Reduced DO can affect swimming performance in salmonids (Bjornn and Reiser 1991). Reduced swimming performance could reduce an affected fish's ability to forage, and to escape predation. Salmon avoidance reactions have been observed when DO levels dropped below 5.5 mg/l (Hicks 1999), which could drive fish from preferred forage areas, or may drive them away from shelter and thereby increase the risk of predation. The frequency of dredging in these channels suggests that the accumulation of anaerobic sediments would be very limited. The low expected levels of oxygen demand, combined with the high rates of river flow and tidal exchange in these channels support the understanding that any reduction in DO would be very small and short-lived. The exact effects of this exposure are uncertain, but the most likely effect would be temporary avoidance of the affected area with no detectable effects on the fitness of an exposed individual.

The WQMP for this action is intended to limit turbidity plumes to 300 feet in these channels. It also requires that dredging and/or in-water sediment disposal operations halt if turbidity exceeds 600 feet (Appendix 2). The COE has committed to comply with those standards. Therefore the extent of detectable water quality impacts from dredging and/or in-water sediment disposal are not expected to exceed that range.

<u>2.4.3.6 Altered Benthic Habitat:</u> Alteration of benthic habitats would cause minor effects in PS Chinook salmon and PS steelhead. As described above at 2.4.1.6, dredging and in-water disposal of sediments alters benthic habitats and reduces the abundance of infaunal and epifaunal invertebrate organisms and submerged aquatic vegetation (SAV). It also alters the population structure of benthic organisms within the affected area, and simplifies the character of the substrate. Repeated dredging and in-water disposal acts to maintain reduced abundance and altered population structures as compared to what would occur in the absence of dredging. Therefore, the proposed maintenance dredging of the Snohomish Channel and the Upper Duwamish Waterway would temporarily reduce or eliminate benthic organisms within the affected areas, and over the long term, would maintain reduced and altered benthic populations in the affected areas as compared to undisturbed areas.

Disposal of dredged material at Jetty Island would be accomplished via a hydraulic pipeline dredge that would discharge sandy sediments at the top of the island. From there, the material would be allowed to flow downslope to intertidal substrate along the west side of the island, where waves and currents would disperse the material over time. This may cause negligible direct impacts on benthic invertebrates, but any loss of organisms would be brief and virtually undetectable. Further, the placement of the material helps maintain the shallow intertidal flats by replacing sediments that are lost due to natural longshore drift, but which cannot be replaced naturally due to the presence of Jetty Island. Because planktonic organisms such as the larvae of many benthic species, as well as copepods, euphausiids, and larval fish are prey for juvenile salmon (NMFS 2006a), continued dredging and sediment disposal would reduce the availability of planktonic prey for juvenile salmonids. However, the relatively small size of the affected areas as compared to the rest of the benthic habitat near these sites, combined with the high levels of water mixing, suggest that any reduction in the availability of planktonic prey for juvenile salmonids would be undetectable.

The removal of SAV in these channels may reduce the availability of natural cover for juvenile salmon that pass through those areas. However, the affected areas are a small part to the total available SAV-supporting substrate in and near those channels, and the abundance of SAV within the channels is limited due to previous dredging. Additionally, the dredging would only remove SAV near the center of the affected streams. It would not affect SAV in the shallower areas along the sides of the channels that are more likely to be used by juvenile salmon. The sediment disposal on Jetty Island may cause negligible direct impacts on SAV, but would enhance SAV-supporting habitat along the west side of the island. Therefore, the effects on juvenile salmon from the reduced availability of cover through dredging-related removal of SAV are likely to be undetectable. Adult PS Chinook salmon and PS steelhead neither prey on planktonic larvae, nor do they utilize SAV for cover. Therefore, they would be unaffected by the expected alterations of benthic habitat.

2.4.3.7 Critical Habitat: The planned dredging and sediment disposal is likely to adversely affect critical habitat that has been designated for PS Chinook salmon and PS steelhead in the Snohomish Channel and the Upper Duwamish Waterway. Both channels are located well downstream from known rearing areas and they largely the features that support rearing juvenile salmon, particularly in the Upper Duwamish Waterway. Therefore, the expected effects on PS Chinook salmon and PS steelhead critical habitat from completion of the proposed action at both sites, including full application of the conservation measures and BMP, would be limited to the impacts on the PBF of freshwater migration corridors and estuarine areas as described below. Disposal of dredged sediments at Jetty Island would also affect the PBF of nearshore marine areas. This assessment considers the intensity of expected effects in terms of the change they would cause in affected PBF 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.

1. Freshwater spawning sites – Does not occur in the action area.
2. Freshwater rearing sites – Does not occur in the action area.

3. <u>Freshwater migration corridors free of obstruction and excessive predation</u>
    a. Free of obstruction and excessive predation – The proposed work may cause ephemeral minor avoidance of the area around ongoing dredging due to elevated noise, activity, and reduced water quality. Because the affected areas would be very small and would not prevent movement around the work area, the action would cause no meaningful effect on this PBF's ability to support migration of PS Chinook salmon and PS steelhead. Also, the work would cause no change in the abundance of predators, nor would it cause conditions that would improve the success of predators. Therefore, the action would cause no change in the quality and function of this PBF.
    b. Water quality – Continued maintenance dredging will cause episodic ephemeral effects on water quality. It would cause no measurable changes in water temperature and salinity, but would periodically mobilize contaminants and suspended sediments into the water column, and may also periodically reduce DO in the water column. Detectable effects on water quality is expected to be limited to the area within 600 feet of dredging, and are not expected to persist past several hours following the cessation of dredging. Therefore the action would cause no long-term change in the quality and function of this PBF.
    c. Water quantity – Continued maintenance dredging would cause virtually no effect on water quantity. The amount of water taken up during dredging is virtually undetectable against the water volumes in the affected water bodies, and the water is quickly returned to the system during sediment disposal. Therefore, the action would cause no detectable effect on this PBF's ability to support PS Chinook salmon and PS steelhead, and no change in the quality and function of this PBF.
    d. Natural Cover – Continued maintenance dredging will cause long-term minor effects on natural cover in that it would periodically remove SAV and woody debris, and maintain previously altered habitats at reduced levels of both features as compared to undisturbed areas. However, the affected areas are a small part to the total available cover-supporting substrate in and near the channels, and the dredging will occur near the center of the channels where the water is deepest. Further, the dredging would not affect SAV or woody debris in the shallower areas along the sides of the channels that are more likely to be used by the juvenile salmon that will migrate through the affected stream reaches. Therefore, the action would cause no meaningful effect on this PBF's ability to support PS Chinook salmon and PS steelhead, and no change in the quality and function of this PBF.
4. <u>Estuarine Areas free of obstruction and excessive predation</u>
    a. Free of obstruction and excessive predation – Same as above.
    b. Water quality (including salinity) – Same as above.
    c. Water quantity – Same as above.
    d. Natural Cover – Same as above.
    e. Forage – Continued maintenance dredging will cause long-term minor effects on forage in that it would periodically remove benthic organisms and maintain previously altered habitats at reduced levels of prey abundance and altered populations as compared to undisturbed areas. However, the affected areas are very small parts to the total available forage-producing substrate in the areas near the channels. The small reduction of available larvae would be undetectable due to the high levels of mixing of the affected waters with the vastly larger volume of unaffected water. Therefore, the action would cause no meaningful effect on this PBF's ability to support PS Chinook salmon and PS steelhead, and no change in the quality and function of this PBF.

5. Nearshore marine areas free of obstruction and excessive predation (Snohomish Channel)
    a. Free of obstruction and excessive predation – Continued sediment disposal at Jetty Island would cause virtually no effect on migration, nor would it cause changes in the abundance of predators. Further, it may improve the success predator avoidance through long-term maintenance of shallow intertidal habitat that supports SAV along the west side of the island. The work Therefore, the action would cause no detectable negative effects on this PBF's ability to support PS Chinook salmon, and may improve the quality and function of this PBF.
    b. Forage – Continued sediment disposal at Jetty Island may cause episodic minor short-term effects on benthic organisms, but it also maintains shallow intertidal habitat that supports benthic invertebrate and SAV populations, which likely improves forage production along the west side of the island. Therefore, the action would cause no detectable negative effects on this PBF's ability to support PS Chinook salmon, and may improve the quality and function of this PBF.
    c. Natural Cover – Continued sediment disposal at Jetty Island would cause virtually no negative effects on existing SAV, and it maintains shallow intertidal habitat that supports SAV populations, which likely improves natural cover along the west side of the island. Therefore, the action would cause no detectable negative effects on this PBF's ability to support PS Chinook salmon, and may improve the quality and function of this PBF.
    d. Water quantity – Continued sediment disposal at Jetty Island returns the small amount of water that is removed during hydraulic pipeline dredging near the site. Therefore, it would cause no detectable effect on this PBF's ability to support PS Chinook salmon, and no change in the quality and function of this PBF.
    e. Water quality – Continued sediment disposal at Jetty Island may cause episodic ephemeral effects on water quality. It would cause no measurable changes in water temperature and salinity, but would periodically mobilize contaminants and suspended sediments into the water column, and may also periodically reduce DO in the water column. Detectable effects on water quality is expected to be limited to the area within 600 feet of disposal, and are not expected to persist past several hours following the cessation of work. Therefore the action would cause no long-term change in the quality and function of this PBF.
6. Offshore marine areas – Does not occur in the action area.

2.5 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 the consultation (50 CFR 402.02). Future federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to Section 7 of the ESA.

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 Range-wide Status of the Species and Critical Habitat (Section 2.2).

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 Environmental Baseline sections above. The contribution of non-federal activities to those conditions include past and on-going shoreline development, aquaculture, and maritime activities, as well as upstream forest management, agriculture, urbanization, road construction, water development, and restoration activities. Those actions were driven by a combination of economic conditions that characterized traditional natural resource-based industries, general resource demands associated with settlement of local and regional population centers, and the efforts of social groups dedicated to river restoration and use of natural amenities, such as cultural inspiration and recreational experiences.

NMFS is unaware of any specific future non-federal activities that are reasonably certain to affect the action area. However, NMFS is reasonably certain that future non-federal actions such as the previously mentioned shoreline and upstream 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 and act against the recovery of ESA-listed aquatic species in the watersheds of all eight project sites. The intensity of these influences depends on many social and economic factors, and therefore is difficult to predict. Further, the adoption of more environmentally acceptable practices and standards may gradually reduce some negative environmental impacts over time. Interest in restoration activities has increased as environmental awareness rises among the public. State, tribal, and local governments have developed plans and initiatives to benefit ESA-listed PS Chinook salmon and PS steelhead within several watersheds of the action area. Those actions may also benefit ESA-listed eulachon and green sturgeon that are within or downstream of watersheds where restoration actions are taken. 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.

Additionally, some future non-federal activities are reasonably certain to contribute to climate change effects within the action area. However, the degree to which future habitat conditions degrade because of climate change, and to what level future non-federal actions are likely to continue or exacerbate existing trends cannot be readily determined. Qualitatively, climate change is likely to adversely affect the overall conservation value of designated critical habitat, though it may have some beneficial effects in certain circumstances. The adverse effects are likely to include, but are not limited to, reduction of cold-water habitat and other variations in quality and quantity of tributary spawning, rearing and migration habitats. It is also likely to include the conversion of estuarine tidal marshes to shallow and deep subtidal habitats as sea levels rise (see Section 2.2).

2.6 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 2.4) to the environmental baseline (Section 2.3) and the cumulative effects (Section 2.5), 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 for the conservation of the species.

As described in more detail above at section 2.2, 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 PBF 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 DO, as well as by causing more frequent and more intense flooding events. It 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 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, substrate, and the biological environment are expected to be of such a small scale that no detectable effects on ESA-listed species or critical habitat through synergistic interactions with the impacts of climate change are expected.

2.6.1 ESA-listed Species

Each of the species considered in this Opinion is 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. Each species will be affected over time by cumulative effects, some positive – as recovery plan implementation and regulatory revisions increase habitat protections and restoration, and some negative – as climate change and unregulated or difficult to regulate sources of environmental degradation persist or increase. Overall, to the degree that habitat trends are negative, as described below, effects on viability parameters of each species are also likely to be negative. In this context we consider the effects of the proposed action's effect on individuals of the listed species at the population scale.

2.6.1.1 PS Chinook Salmon: The five dredging sites within the Puget Sound are all located in waters that may be occupied by PS Chinook salmon, and predominantly support adult and juvenile migration. The long-term abundance trend of this ESU is slightly negative, including in the Snohomish and Green River systems. Although the Whidbey Basin MPG, which includes the Snohomish River, is considered to be at relatively low risk of extinction, the Central/South Puget Sound MPG, which includes the Green River, is considered at high risk of extinction due to low abundance and productivity. 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 environmental baseline within the action area has been degraded by the effects of nearby streambank and shoreline development and by maritime activities. The baseline has also been degraded by nearby and upstream industry, urbanization, agriculture, forestry, water diversion, and road building and maintenance.

Dredging-related work overlaps with the timing of returning adult PS Chinook salmon, but not with the presence of rearing or out-migrating juveniles. No direct mortality of any individuals is expected due to entrainment or other effects. However, over the next 25 years, low numbers of returning adults may be briefly exposed to contaminants that are mobilized by dredging. No injury is expected from the brief exposures, but minor impacts on reproductive success for low numbers of individuals is possible. The exact number of fish that may be affected is unknown, but is expected to represent an extremely small fraction of the returning cohort. This is supported in a recent consultation for similar dredging in salmon habitat where in addition to exposure to dredging-related contaminants, salmon mortality is expected due to entrainment (NMFS 2017b). In that consultation, the percentages of take within individual populations ranged from about 0.004% to 0.21% of a cohort. Because this action is not expected to cause entrainment, the percent of the affected runs is likely to be much lower. The number of individual PS Chinook salmon that may be directly affected by the proposed action would be too low to affect any of the characteristics of a viable salmon population (abundance, productivity, distribution, or genetic diversity) for any PS Chinook salmon population.

The planned dredging occurs very low in, or outside of, the affected watersheds, and is not causing, nor would it worsen any of the factors that are believed to be limiting the recovery of this species within the action area. Although it would maintain habitat features near the center of the affected waterways at reduced functional levels as compared to undisturbed areas, it would cause no detectable effects on the benthic habitat along the sides of the channels where juveniles are most likely to occur during their out-migrations through the area. Further, the absence of the planned dredging would not significantly improve the affected waterways' ability to support this ESU because it would not create conditions that would lead to the improvement of streambank and nearshore marine habitats that have been heavily impacted by over 100 years of intense shoreline development and hardening, especially in and near the Snohomish and Duwamish channels.

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 any population level impacts on PS Chinook salmon. Therefore, the proposed action would not appreciably reduced the likelihood of survival and recovery of this listed species.

<u>2.6.1.2 PS Steelhead</u>: The Snohomish and Duwamish Channels are located in waters that are occupied by PS steelhead, and predominantly support adult and juvenile migration. The PS steelhead DPS is currently considered "not viable", and the extinction risk for most DIPs is estimated to be moderate to high. Long-term abundance trends have been predominantly negative or flat across the DPS, especially for natural spawners, and growth rates are currently

declining at 3 to 10% annually for all but a few DIPs. The abundance trend between 1999 and 2014 is negative for all Snohomish and Green River DIPs, but has been neutral to slightly positive since 2009 for the Pilchuck River winter run and the Green River winter run. Reduced or eliminated accessibility to historically important habitat, combined with degraded conditions in available habitat due to land use activities appear to be the greatest threats to the recovery of PS steelhead. Fisheries activities also continue to impact this species. The environmental baseline of these dredging sites has been degraded by the effects of nearby streambank and shoreline development and by maritime activities. The baseline has also been degraded by nearby and upstream industry, urbanization, agriculture, forestry, water diversion, and road building and maintenance.

Dredging-related work overlaps with the timing of returning adult PS steelhead, but not with the presence of rearing or out-migrating juveniles. No direct mortality of any individuals is expected due to entrainment or other effects. However, over the next 25 years, low numbers of returning adults may be briefly exposed to contaminants that are mobilized by dredging. No injury is expected from the brief exposures, but minor impacts on reproductive success for low numbers of individuals is possible. The exact number of fish that may be affected is unknown, but is expected to represent an extremely small fraction of the returning cohort. This is supported in a recent consultation for similar dredging in salmon habitat where in addition to exposure to dredging-related contaminants, salmon mortality is expected due to entrainment (NMFS 2017b). In that consultation, the percentages of take within individual populations ranged from about 0.004% to 0.21% of a cohort. Because this action is not expected to cause entrainment, the percent of the affected runs is likely to be much lower. The number of individual PS steelhead that may be directly affected by the proposed action would be too low to affect any of the characteristics of a viable salmon population (abundance, productivity, distribution, or genetic diversity) for any PS steelhead population.

The planned dredging occurs very low in the affected watersheds, and is not causing, nor would it worsen any of the factors that are believed to be limiting the recovery of this species within the action area. Although it would maintain habitat features near the center of the affected waterways at reduced functional levels as compared to undisturbed areas, it would cause no detectable effects on the benthic habitat along the sides of the channels where juveniles are most likely to occur during their out-migrations through the area. Further, the absence of the planned dredging would not significantly improve the affected waterways' ability to support this DPS because it would not create conditions that would lead to the improvement of streambank and nearshore marine habitats that have been heavily impacted by over 100 years of intense shoreline development and hardening.

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 any population level impacts on PS steelhead. Therefore, the proposed action would not appreciably reduced the likelihood of survival and recovery of this listed species.

<u>2.6.1.3 Southern Eulachon:</u> Grays Harbor and the Chehalis River are located in waters that are occupied by southern eulachon. Specific trend information is unavailable for these two water

sheds. However, in general, the abundance of the southern eulachon DPS declined abruptly in the early 1990s, briefly improved in the early 2000s, then returned to very low levels. Abundance has generally improved since then, but there is no evidence that abundance has returned to pre-1990 levels, and recent poor ocean conditions suggest that population declines may be widespread in the near future. Freshwater habitat loss and degradation appear to be the greatest threats to the recovery of southern eulachon. The environmental baseline at these dredging sites has been degraded by the effects of nearby streambank and shoreline development and by maritime activities. The baseline has also been degraded by nearby and upstream industry, urbanization, agriculture, forestry, water diversion, and road building and maintenance. Dredging-related work in Grays Harbor and the Chehalis River overlaps with the timing of returning adults and out-migrating eulachon larvae. Over the next 25 years, low numbers of both life stages may be annually entrained and killed by hydraulic dredging and in-water sediment disposal. Low numbers of both life stages may also be briefly exposed to contaminants and reduced dissolved oxygen (DO) that are mobilized by dredging and in-water disposal. No injury is expected in adults from the brief exposures, but minor impacts on reproductive success for low numbers of individuals is possible. Low numbers of larvae may be injured or killed by exposure to contaminants and/or to water with reduced DO in Westhaven Cove.

The exact number of fish that may be affected by these stressors is unknown, but is expected to represent an extremely small fraction of the returning cohort. This is supported in a recent consultation for similar dredging in eulachon-occupied estuarine habitats along the west coast of Oregon (NMFS 2017b). In addition to exposure to dredging-related contaminants, about 0.004% to 0.21% of individual salmon cohorts are expected to be entrained during dredging. No entrainment of eulachon was expected due to very little overlap between the planned dredging and the presence of eulachon. Although the entrainment rate above is for salmon, NMFS believes that it gives a reasonable proxy for eulachon entrainment because the dredging considered in that consultation is virtually identical to the dredging considered here, and because the migratory behaviors of returning adult eulachon are highly similar to that of salmon, whereas out-migrating eulachon larvae would quickly flow out of the action area instead of remaining in the estuarine waters as do salmon. Based on this, the number of individual southern eulachon that may be directly affected by the proposed action would be too low to population-level effects.

The planned dredging occurs very low in the affected watersheds, and is not causing, nor would it worsen any of the factors that are believed to be limiting the recovery of this species within the action area. Although dredging would maintain habitat features near the center of the affected waterways at reduced functional levels as compared to undisturbed areas, that impact would cause no detectable effects on any life stage of eulachon in the action area. Further, the absence of the planned dredging would not significantly improve the affected waterways' ability to support this DPS because adult and larval eulachon do not hold in estuarine habitats, and the dredging is well removed from expected spawning habitat.

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 any population level impacts on southern eulachon. Therefore, the proposed action would not appreciably reduced the likelihood of survival and recovery of this listed species.

2.6.1.4 Southern Green Sturgeon: Sub-adult and adult Southern green sturgeon use the Grays Harbor estuary for feeding and growth. Abundance of this DPS is estimated at 824 to 1,872 spawning adults, but no data are currently available to establish any trends in population growth or decline. The greatest extinction risk for the DPS is that it consists of a single known population that spawns in a limited portion of the Sacramento River, which has been degraded by land use activities and water diversions. The environmental baseline at Grays Harbor has been degraded by the effects of nearby streambank and shoreline development and by maritime activities. The baseline has also been degraded by nearby and upstream industry, urbanization, agriculture, forestry, water diversion, and road building and maintenance.

Dredging-related work in Grays Harbor overlaps with the seasonal presence of adult and sub-adult green sturgeon. Over the next 25 years, a total of six individuals of this DPS are expected to be fatally entrained by hydraulic dredging, and a low but undetermined number of this DPS may also be killed by in-water disposal of dredged sediments. Low numbers of individuals may also be briefly exposed to contaminants and/or water with reduced dissolved oxygen (DO) during dredging and in-water disposal. No injury is expected from the brief exposures, but minor impacts on growth are possible due to exposure to water with reduced DO during dredging in Westhaven Cove. Reduced prey availability in the channels and the in-water disposal areas may also cause minor impacts on growth in some individuals.

The planned dredging occurs outside of green sturgeon spawning and juvenile rearing habitat, and is not causing, nor would it worsen any of the factors that are believed to be limiting the recovery of this species within the action area. Although dredging and in-water disposal act to maintain reduced prey availability, especially in the channel where sturgeon may congregate and forage during daylight hours, that effect is expected to be very minor because the affected area only accounts for about 1.3% of the 74,000 acres of potential forage habitat in the bay. The absence of the planned dredging would slightly improve prey availability in the bay, but would not otherwise significantly improve the affected waterway's ability to support this DPS because it would not create conditions that would lead to the improvement of habitat conditions across the majority of bay, which have been impacted by over 100 years of shoreline development and maritime activities.

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 any population level impacts on southern green sturgeon. Therefore, the proposed action would not appreciably reduced the likelihood of survival and recovery of this listed species.

2.6.2 Critical Habitat

As described above at Section 2.4, the proposed action is likely to adversely affect designated critical habitat for PS Chinook salmon, HCSR chum salmon, and PS steelhead; for PS/GB bocaccio; and for southern green sturgeon.

2.6.2.1 Critical Habitat for PS Chinook Salmon, HCSR Chum Salmon, and PS Steelhead: The specific incidence of designated critical habitat for PS Chinook salmon, HCSR chum salmon, and PS steelhead varies somewhat across the Puget Sound portion of the action area. However, the essential PBF of designated critical habitat are identical for all three species, with the exception that no nearshore PBF has been designated for PS steelhead. Further, the site-specific differences in species and PBF are described in detail in Section 2.4, and the effects on the respective PBF are identical for all three species. Therefore, in the interest of simplicity, salmonid critical habitat is discussed here as if for a single species with no specific distinction made for individual species or for specific project sites.

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

The essential PBF of salmon critical habitat that would be affected by the proposed action is limited to estuarine areas and nearshore areas. The site attributes that would be affected by the action are limited to freedom from obstruction and excessive predation, and water quality. The action would cause no detectable effects on any other attributes. At most, the action would cause episodic and ephemeral minor interruptions of adult migrations within about 177 feet, and episodic and ephemeral reduction in water quality within 600 feet, of on-going dredging. Based on the best available information, the scale of the proposed action’s effects, when considered in combination with the degraded baseline, cumulative effects, and the impacts of climate change, would be too small to cause any detectable long-term changes in the quality or function of either PBF. Therefore, this critical habitat will remain functional, or retain its current ability for PBF to become functionally established, to serve the intended conservation role for PS Chinook salmon, HCSR chum salmon, and PS steelhead.

2.6.2.2 Critical Habitat for PS/GB Bocaccio: Nearshore critical habitat for juvenile PS/GB bocaccio 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 essential PBF of PS/GB bocaccio critical habitat that would be affected by the proposed action is limited to nearshore juvenile settlement habitats that support kelp. The site attribute that would be affected by the action is limited to water quality. The action would cause no detectable effects on any of the other attributes. At most, the action would cause episodic and ephemeral reduction in water quality within 600 feet of on-going dredging at Port Townsend and Keystone Harbors. Based on the best available information, the scale of the proposed action's effects, when considered in combination with the degraded baseline, cumulative effects, and the impacts of climate change, would be too small to cause any detectable long-term changes in the quality or function of this PBF. Therefore, this critical habitat will remain functional, or retain its current ability for PBF to become functionally established, to serve the intended conservation role for PS/GB bocaccio.

<u>2.6.2.3 Critical Habitat for Southern Green Sturgeon:</u> Past and ongoing land and water use practices related to agriculture and urbanization have adversely altered stream morphology as well as water quality and availability in the freshwater riverine critical habitat that supports southern green sturgeon spawning and rearing. Nearshore coastal marine and estuarine critical habitat has been impacted by shoreline development, maritime and fishing activity, and aquaculture that have degraded or reduced the availability of appropriate substrates and benthic resources, and reduced water quality in many areas along the Pacific coast. Derelict fishing gear also likely reduces the quality of coastal marina habitat through altered bottom composition, reduced prey availability, and direct mortality of sturgeon. Global climate change will likely increase in-stream water temperatures and alter stream flows, possibly exacerbating impacts on baseline conditions in freshwater critical habitat. Rising sea levels are expected to increase coastal erosion and reduce the availability and quality of nearshore and estuarine habitats. Elevated sea surface temperatures and increased ocean acidification may also reduce the quality of nearshore marine and estuarine habitats, and reduce prey availability by reducing ocean productivity. In the future, non-federal land and water use practices and climate change are likely to increase and continue acting against the quality of green sturgeon critical habitat. The intensity of those influences on critical habitat is uncertain, as is the degree to which those impacts may be tempered by adoption of more environmentally acceptable land and water use practices, by the implementation of non-federal plans that are intended to benefit sturgeon, and by efforts to address the effects of climate change.

The essential PBF of southern green sturgeon critical habitat that would be affected by the proposed action is limited to coastal bays and estuaries, and coastal marine areas. The site attributes that would be affected by the action is limited to food resources and water quality. The action would cause do detectable effects on any of the other attributes. The action would act to maintain reduced prey availability in the channel, which accounts for about 1.3% of the potential forage habitat in the bay, to cause episodic and ephemeral reduction in water quality within 1,200 feet of on-going dredging and in-water disposal. Based on the best available information, the scale of the proposed action's effects, when considered in combination with the degraded baseline, cumulative effects, and the impacts of climate change, would be too small to cause any detectable long-term changes in the quality or function of either PBF. Therefore, this critical habitat will remain functional, or retain its current ability for PBF to become functionally established, to serve the intended conservation role for southern green sturgeon.

2.7 Conclusion

After reviewing and analyzing the current status of the listed species, the environmental baseline within the action area, the effects of the proposed action, any effects of interrelated and interdependent actions, and cumulative effects, it is NMFS' opinion that the proposed action is not likely to jeopardize the continued existence of PS Chinook salmon, PS steelhead, southern eulachon, or southern green sturgeon, nor is it likely to destroy or adversely modify designated CH for PS Chinook salmon, HCSR chum salmon, PS steelhead, PS/GB bocaccio, or southern green sturgeon.

2.8 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).

2.8.1 Amount or Extent of Take

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

1. Very low numbers of adult and larval southern eulachon will be killed by entrainment during hydraulic dredging and by exposure to in-water sediment disposal. Very low numbers of adult and larval eulachon are also likely to experience sub-lethal effects from exposure to contaminants mobilized during dredging and in-water disposal. Very low numbers of larval eulachon are also likely to experience sub-lethal and lethal effects from exposure to water with reduced DO during dredging.

2. Up to 6 adult and sub-adult southern green sturgeon will be killed by entrainment during hydraulic dredging, and very low numbers of adult and sub-adult southern green sturgeon will be injured or killed by exposure to in-water sediment disposal. Very low numbers of adult and sub-adult southern green sturgeon are also likely to experience sub-lethal effects from reduced forage availability, and exposure to water with reduced DO and contaminants and mobilized during dredging.

3. Very low numbers of adult PS Chinook salmon are likely to experience sub-lethal effects from exposure to contaminants mobilized during dredging.

4. Very low numbers of adult PS steelhead are likely to experience sub-lethal effects from exposure to contaminants mobilized during dredging.

NMFS lacks empirical data to accurately predict the exact number of eulachon that would be killed by entrainment. Additionally, no information is currently available to accurately estimate eulachon density in the action area. Further, their presence within the action area is driven by a complex and interactive mix of biotic and environmental processes that act to randomize their distribution and abundance across temporal and spatial scales. Therefore, we cannot predict with meaningful accuracy the number of eulachon that are reasonably certain to be killed by entrainment and in-water sediment disposal, or that would be exposed to contaminants or low DO.

NMFS estimates that up to 6 southern green sturgeon are likely to be injured or killed by dredge entrainment. This is based on documented entrainment of sturgeon during other hopper dredging actions. The best available science, suggests that about two thirds (66.7%) of the total number of entrained sturgeon would be observed. Therefore, we use an amount of observed take, prorated against the percent of observer coverage for the entrainment of green sturgeon during dredging.

However, as with eulachon, no information is currently available to accurately estimate southern sturgeon density in the action area, and their distribution and abundance within the action area would be unpredictable across temporal and spatial scales. Therefore, we cannot accurately estimate the number of southern green sturgeon that are reasonably certain to be killed underwater by sediment disposal or that would be exposed to contaminants, low DO, or reduced forage resources. Similarly, with PS Chinook Salmon and PS steelhead, no information is currently available to accurately estimate their density in the action area, and their distribution and abundance within the action area would be unpredictable across temporal and spatial scales. Thus, we cannot accurately estimate the number of PS Chinook salmon and PS steelhead that are reasonably certain to be exposed to contaminants.

NMFS knows of no device or practicable technique that would allow safe observation during dredging and disposal operations that would yield reliable counts of eulachon that would be entrained during dredging; of eulachon and green sturgeon that would be impacted by in-water sediment disposal; of eulachon, green sturgeon, PS Chinook salmon, and PS steelhead that would be exposed to contaminants; of eulachon or green sturgeon that would be exposed to low DO; or of green sturgeon that would be exposed to reduced forage availability. In such circumstances, NMFS uses the causal link established between the activity and the likely 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 volume of hydraulically dredged material is the best available surrogate for the extent of take of eulachon from entrainment. This is because entrainment is positively correlated with the volume of material removed. Therefore, as the amount of hydraulically dredged material increases, the likelihood of eulachon entrainment increases, despite their low density and random ditribution in the action area. Similarly, the total volume of material to be dredged is the best available surrogate for the extent of take of eulachon and green sturgeon from sediment impact during in-water disposal, because the potential for fish to be entrained in the disposal plume also increases with the volume of material disposed. The total volume of material to be dredged and the size and location of the impacted area are the best available surrogates for the extent of take of green sturgeon from reduced prey availability because the lost benthic prey is positively correlated with the volume of material removed. The total volume of material to be dredged and the extent of the turbidity plume are the best available surrogates for the extent of take of eulachon, green sturgeon, PS Chinook salmon, and PS steelhead from exposure to contaminants and the extent of take of eulachon and green sturgeon from exposure of low DO because mobilized pollutants and low DO would be positively correlated with the volume of material removed, and the number of fish exposed would be is positively correlated with the volume of the turbidity plume within which the pollutants would be present.

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

1. Adult and larval southern eulachon:
    a. The volume of sediments removed by any form of hydraulic dredging during any dredging season shall not exceed: 1.9 million cubic yards (CY) in Grays Harbor and Westhaven Cove combined; and 100,000 CY in the Quillayute River;
    b. The total volume of sediments removed by any form of dredging during any dredging season shall not exceed: 4.5 million CY in Grays Harbor and Westhaven Cove, combined; and 100,000 CY in the Quillayute River;
    c. Turbidity shall not exceed 10 NTU over background when the background is 50 NTU or less, or a 20 percent increase in turbidity when the background turbidity is more than 50 NTU at 1,200 feet from dredging and/or disposal activities in Grays Harbor, or 600 feet in the Quillayute River.

2. Adult and sub-adult southern green sturgeon:
    a. Entrainment of southern green sturgeon during any form of hydraulic dredging shall not exceed 4 observed individuals over the 25-year life of this consultation;
    b. The combined total volume of sediment removal by any form of dredging during any dredging season shall not exceed 4.5 million CY in Grays Harbor and Westhaven Cove;
    c. Dredging anywhere within Grays Harbor shall remain within the current official federal channel boundaries, and shall not exceed 940 acres in total area during any dredging season; and

   d. Turbidity shall not exceed 10 NTU over background when the background is 50 NTU or less, or a 20 percent increase in turbidity when the background turbidity is more than 50 NTU at 1,200 feet from dredging and/or disposal activities in Grays Harbor.

3. Puget Sound Chinook salmon:
   a. The total volume of sediments removed by any form of dredging during any dredging season shall not exceed: 50,000 CY, 75,000 CY, 230,000 CY, 1.2 million CY, and 250,000 CY in the channels at Port Townsend, Keystone, Swinomish Slough, Snohomish River, and in the Upper Duwamish River, respectively;
   b. Turbidity shall not exceed 10 NTU over background when the background is 50 NTU or less, or a 20 percent increase in turbidity when the background turbidity is more than 50 NTU at 600 feet from dredging in Puget Sound channels.

4. Puget Sound steelhead:
   a. The total volume of sediments removed by any form of dredging during any dredging season shall not exceed: 50,000 CY, 75,000 CY, 230,000 CY, 1.2 million CY, and 250,000 CY in the channels at Port Townsend, Keystone, Swinomish Slough, Snohomish River, and in the Upper Duwamish River, respectively;
   b. Turbidity shall not exceed 10 NTU over background when the background is 50 NTU or less, or a 20 percent increase in turbidity when the background turbidity is more than 50 NTU at 600 feet from dredging in Puget Sound channels.

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

2.8.2 Effect of the Take

In the Opinion, NMFS determined that the amount or extent of anticipated take, coupled with other effects of the proposed action, is not likely to result in jeopardy to the species or destruction or adverse modification of CH (Section 2.7).

2.8.3 Reasonable and Prudent Measures (RPM)

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

The NMFS believes that the full application of minimization measures included as part of the proposed action, together with use of the reasonable and prudent measures (RPMs) and terms and conditions described below, are necessary and sufficient to avoid, minimize, and offset the incidental take of listed species resulting from the proposed action.

The COE shall:

1. Minimize the incidental take from dredging and in-water sediment disposal.

2. Minimize the exposure of listed fish to contaminants and reduced DO.

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

2.8.4 Terms and Conditions

The terms and conditions described below are non-discretionary. The COE or any applicant must comply with them in order to implement the RPM (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.

1. To implement RPM Number 1, Minimize incidental take from dredging and in-water sediment disposal, the COE shall:

   a. Require dredge operators to comply with the COE best management practices (BMP) outlined in Appendix 1 of this Opinion.
   b. Require dredge operators to use best available technologies to ensure that dredging and/or disposal activities are confined to areas within the current official boundaries of the federal channels and in-water disposal sites;
   c. Require hopper dredge operators to operate in a manner that maintains optimum draghead contact with the substrate;
   d. Require all hydraulic-type dredge operators to minimize pump operations when dragheads and/or cutter heads are above the substrate;
   e. Require dredge operators to limit the dredge prism and the volume of removed sediment to the minimum area necessary to achieve project goals; and
   f. Halt all hydraulic dredging in Grays Harbor if observed southern green sturgeon entrainment exceeds 2 over the 25-year life of this consultation (based on 50% observer coverage of hopper dredging during May and June), or if observed southern green sturgeon entrainment exceeds 4 over the 25-year life of this consultation (based on 100% observer coverage of hopper dredging during May and June).

2. To implement RPM Number 2, Minimize the exposure of listed of listed fish to contaminants and reduced DO, the COE shall:

   a. Limit dredging to areas where sediments meet the Dredged Material Management Program (DMMP) guidelines for suitability for unconfined aquatic disposal in the marine environment;
   b. Require dredge operators to comply with the water quality monitoring plan (WQMP) outlined in Appendix 2 of this Opinion, or with the current WDOE WQMP for the site if it is more restrictive; and
   c. Require dredge operators to stop dredging when turbidity exceeds 10 NTU above background levels of 50 NTU or less, or exceeds 20% above background levels that are more than 50 NTU at 1,200 feet from dredging and/or sediment disposal in Grays Harbor, and 600 feet for all other channels. Dredging may only resume after turbidity

levels return to compliant levels identified in Appendix 2 or the current WDOE WQMP if it is more restrictive.

3. To implement RPM Number 3, implement a monitoring and reporting program to confirm that the take exemption for the proposed action is not exceeded, the COE shall develop and implement a plan to collect and report details about the take of listed fish. That plan shall:

   a. Require that a competent observer be present during all daylight hopper dredge operations in Grays Harbor during May and June to document entrainment of listed fish;
   b. Require that the observer be sufficiently trained to:
      i. Identify and measure fish;
      ii. Take photographs;
      iii. Collect tissue samples; and
      iv. Complete and submit observation logs;
   c. Require that hopper dredges be equipped and operated in a manner that provides observers with a reasonable opportunity to detect interactions with listed species;
   d. Require that dredging observers shall monitor the best available monitoring structure present aboard the hopper dredge (i.e. debris box or screen), with special emphasis on periods when the dredge pumps would be operated while draghead is raised;
   e. Require dredge operators to maintain and submit dredging logs to verify that all take indicators are monitored and reported. Minimally, logs should include: (1) Type of dredging vessel (mechanical, hydraulic pipeline, hopper); (2) Vessel positon relative to the channel while dredging, or certification that dredging was within the establish channel, and the methods used to confirm vessel location; (3) Volumes of sediment removed/disposed; (4) Extent of turbidity plumes, and compliance with the WQMP; and (5) All incidents of observed entrainment of listed species;
   f. Establish procedures for the submission of observer and dredge operator logs, and other materials, to the appropriate COE office, which will draft and submit reports.
   g. Establish procedures for reporting take and annual monitoring reports, along with results from DMMP sediment testing at the channels considered in this Opinion:
   i. Submit e-mail take reports within 24 hours to: Donald.Hubner@noaa.gov;
   ii. Submit annual reports to NMFS by April 1st for the preceding calendar year at the following address:

National Marine Fisheries Service
Oregon Washington Coastal Office
Attn: WCR-2016-6057
510 Desmond Drive SE, Suite 103
Lacey, WA 98503

2.9 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 reach out to its districts that have more experience with the entrainment of sturgeon and sea turtles to identify methods to reduce entrainment, and to improve monitoring take during dredging operations.

2. The Corps should coordinate with NMFS, other resource agencies, and technical experts to develop and install structures on their hopper dredges, and to develop procedures, that would reduce the likelihood of entrainment of listed species as well improve the likelihood of detecting entrained listed species.

3. The Corps should coordinate with NMFS, other resource agencies, and technical experts to develop and refine improved methods to monitor other forms of incidental take associated with the proposed action.

4. The Corps should encourage contract dredge operators to install the best available equipment and to comply with the best available procedures to reduce entrainment and improve monitoring.

5. The Corps should conduct or support continuing research to better understand the distribution and abundance of listed species in and around the eight federal channels considered in this Opinion. Of particular value would be improved knowledge of: (1) green sturgeon abundance and temporal distribution and habitat use in Grays Harbor; (2) eulachon abundance and temporal distribution and habitat use in the water sheds above Grays Harbor and the Quillayute River; and (3) green sturgeon and eulachon distribution and abundance in Puget Sound watersheds.

6. The Corps should use its authority and resources to improve aquatic habitat conditions in the watersheds of Washington State. Examples include:

a. Use of any logs, root wads, or other woody debris removed during dredging for restoration projects in the watershed from which they were removed;

b. Work with the Puget Sound Partnership and Water Resource Inventory Area (WRIA) restoration groups to help restore and/or protect upstream watersheds that flow into Puget Sound and coastal waters of the State;

c. Work with NMFS, other resource agencies, and technical experts to improve the design of existing and future streambank stabilization structures to include the best available techniques reduce their impacts on environmental effects on;

d. Conduct watershed-level programmatic consultations with NMFS for the maintenance of COE-maintained streambank stabilization structures throughout the State, especially in watersheds that support ESA-listed salmonids; and

e. Remove derelict structures, such as abandoned vessels and old piles, from the waterways of the State.

2.10 Reinitiation of Consultation

This concludes formal consultation for the U.S Army Corps of Engineers' (COE) maintenance dredging program for eight federally-authorized navigation channels around the Puget Sound and along the west coast of Washington State. As 50 CFR 402.16 states, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained or is authorized by law and if: (1) The amount or extent of incidental taking specified in the ITS is exceeded, (2) new information reveals effects of the agency action that may affect listed species or CH in a manner or to an extent not considered in this Opinion, (3) the agency action is subsequently modified in a manner that causes an effect on the listed species or CH that was not considered in this Opinion, or (4) a new species is listed or CH designated that may be affected by the action.

2.11 Not Likely to Adversely Affect Determinations

This concurrence 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. Refer to the opinion for a description of the proposed action and action area. As described in section 1.2, the COE determined the proposed action is not likely to adversely affect all of the species and critical habitats identified in Table 2. However, as described in the Opinion above, NMFS has concluded that the proposed action is likely to adversely affect PS Chinook salmon, PS steelhead, southern eulachon, and southern green sturgeon, and critical habitat designated for PS Chinook salmon, HCSR chum salmon, PS steelhead, PS/GB bocaccio, and southern green sturgeon. Our concurrence with the COE "not likely to adversely affect" determinations for the remaining species and critical habitat, as identified in Table 2 as "Not Likely to Adversely Affected" follows.

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.

Due to the wide-spread nature, and varying locations of the eight navigation channels considered in this Opinion, the affected species and CH vary between project locations. For clarity, this section is organized according to commonalities between sites based on their locations, the critical habitat that is present, and the listed species that may be affected. The site grouping used in this section is identical that used above in section 2.4. The navigation channels at Grays Harbor, Westhaven Cove Small Boat Basin (within Grays Harbor), and at Quillayute River are considered together. The navigation channels at Port Townsend Harbor, Keystone Harbor, and the Swinomish Slough are considered together; and the navigation channels at Everett Harbor/Snohomish River and the Upper Duwamish Waterway are considered together.

As described above in Section 2.4, the potential stressors arising from the proposed action that could cause direct effects on listed marine species include: (1) Entrainment (including dredging and in-water sediment disposal); (2) Bucket strike; (3) Vessel collision; (4) Elevated noise; and (5) Degraded water quality. Indirect effects may also be caused by impacts on forage resources.

2.11.1 Grays Harbor, Westhaven Cove Small Boat Basin, and Quillayute River Navigation Channels

In the Grays Harbor channel, listed marine species would have to be within 1,200 feet of dredging activities to be potentially exposed to any of the stressors identified above, with the exception of elevated noise, and potential impacts through trophic webs. The range drops to 600 feet for the channels at Westhaven Cove and Quillayute River. Based on the locations of these channels, NMFS considers it highly unlikely that any salmon from the Columbia River, the Puget Sound, or the Willamette River; PS/GB bocaccio, PS/GB yelloweye rockfish; whales; or sea turtles identified above in Table 2 would approach close enough to any of these channels to be exposed to any action-related stressors, with the possible exception of exposure to elevated noise and to impacts through trophic webs.

Marine mammal hearing varies with species and is wider in its spectra than that of fish and sea turtles. The hearing range in mysticetes (baleen whales) is believed to extend between 7 and 35,000 Hz, with peak sensitivity between about 500 and 6,000 Hz, with acoustic sensitivity falling off sharply below and above that range. Mysticetes comprise what is considered the low-frequency cetaceans hearing group. The odontocetes (toothed whales) considered in this Opinion are included in the mid-frequency cetacean hearing group. The hearing range of mid-frequency odontocetes is believed to extend between 150 and 160,000 Hz. Peak sensitivity is between about 10,000 and 100,000 Hz, with sensitivity falling off sharply below and above that range (NMFS 2016). The criteria used by NMFS to estimate the onset of effects in marine mammals (NMFS 2016) considers a combination of factors that include the nature of the sound (frequency, intensity, and whether or not it is impulsive or non-impulsive), the hearing range and sensitivity of the animal, and sound exposure intensity using two metrics; dB_{peak} and accumulated sound energy (based on dB_{SEL} and duration of exposure). Both dB_{peak} and dB_{SEL} are considered for impulsive sounds, whereas only dB_{SEL} is considered for non-impulsive sounds. For impulsive sound sources, the onset of permanent threshold shift (PTS) is expected to occur at any exposure to in-water sound levels of 219 & 230 dB_{peak} (unweighted) and/or accumulated in-water sound levels of 183 & 185 dB_{SEL} (weighted), for low- and mid-frequency marine mammals respectively. The respective exposure thresholds for the onset of temporary threshold shift (TTS) are 213 & 224 dB_{peak} (unweighted) and/or 168 & 170 dB_{SEL} (weighted). For non-impulsive sound sources, the onset of PTS is expected to occur at exposure to accumulated in-water sound levels of 199 & 198 dB_{SEL} (weighted) for low- and mid-frequency marine mammals respectively. The respective exposure thresholds for the onset of TTS are 179 & 178 dB_{SEL} (weighted). The exposure thresholds for the onset of behavioral disturbance (BD) have not yet been updated. The current thresholds for the onset of BD for all marine mammals exposed to in-water sounds are: exposure to impulsive noise $\geq$ 160 dB_{RMS}, and exposure to non-impulsive noise $\geq$ 120 dB_{RMS}.

The available information about sea turtle sensory biology suggests that they are low frequency specialists that rely more heavily on visual cues, rather than auditory, to initiate threat avoidance

(Hazel *et al*. 2007). Green sea turtles are thought to be most acoustically sensitive between 200 and 700 hertz (Hz) (Ridgway *et al*. 1969), and loggerheads are most sensitive between 250 and 1,000 Hz (Bartol *et al*. 1999). Although no specific information is available to describe hearing in the other turtle species considered here, it is highly likely that their hearing is similar to that of green and loggerhead turtles. Currently, no thresholds have been established to estimate the onset of injury for sea turtles that may be exposed to high intensity sounds. Exposure to 150 dB_{SEL} is used in this Opinion to estimate the onset of behavioral disturbance in sea turtles, with the understanding that this would likely overestimate potential impacts.

As described above at 2.4.1, the loudest project-related source would be the echo-sounders used for hydrographic surveys. However, the 200 kHz operating frequency of the echo-sounders is far above the known hearing ranges of fish and sea turtles, as well as above the known hearing range of all marine mammals. The best available information suggests that propulsion noise, especially from hopper dredges, is the project-related source with the greatest range to the onset of behavioral disturbance in marine mammals. As described above at 2.4.1, whale-detectable levels of dredging-related noise (above 120 dB_{RMS}) would, at most, radiate up to 3.4 miles (5,400 m) out from Grays Harbor during hopper dredging, and 1.4 miles (2,200 m) around the entrance to the Quillayute River during hydraulic dredging. However, the ambient noise levels in the action area are likely to routinely exceed 120 dB_{RMS}, and the SL of the large commercial vessels that are common, especially in Grays Harbor, Everett Harbor, and the Port of Seattle can reach 180 to 189 dB_{RMS} (Reine *et al.* 2014a). Conservatively assuming that the source levels of the large commercial vessels is similar to the hopper dredge, the range to the 120 dB_{RMS} isopleth around those vessels would be about 3.4 miles (5,400 m) as they transit into and out of the harbors. Therefore, it is doubtful that marine mammals would be able to detect meaningful sound levels from the hopper dredge except at very close ranges because much of the acoustic signature of the hopper dredge would be lost within the ambient noise, and masked by the routine vessel traffic in and around the harbors. Should any whales approach close enough to hear project related noise, the exposure would, at most, cause brief periods of low-level acoustic masking (virtually undetectable against the ambient noise in the area, and temporary avoidance of the area immediately around the channel entrances. The areal avoidance would not hinder migration through the action area, or limit access to important habitat resources. Therefore, the exposure would cause no meaningful effect on the exposed individuals. The maximum range for acoustic effects on fish and sea turtles would be about 177 feet (54 m). It is highly unlikely that any of the fish or turtles identified in Table 2, other than eulachon and green sturgeon, would be within that range of project-related activities.

Based on the information presented above in section 2.4.1, impacts on prey resources would cause no detectable effects in prey species for any of the species considered here.

The planned dredging is not likely to adversely affect critical habitat that has been designated for leatherback sea turtles. Designated critical habitat for leatherback sea turtles includes marine waters off the entire west coast of Washington State, from the shoreline out to the 2,000-meter isobath. The expected effects on this 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 occurrence of prey species PBF as described below.

1. <u>Prey species, primarily scyphomedusae of the order Semaeostomeae (*Chrysaora*, *Aurelia*, *Phacellophora*, and *Cyanea*), of sufficient condition, distribution, diversity, abundance and density necessary to support individual as well as population growth, reproduction, and development of leatherbacks</u>

Continued maintenance dredging will cause long-term minor effects on prey. It would periodically remove benthic organisms and maintain previously altered habitats at reduced levels of organism abundance and altered populations as compared to undisturbed areas. The larvae of benthic organisms are prey resources for gelatinous zooplankton that are prey for leatherbacks. However, action impacts on larvae production are not likely to be detectable in the water column. Therefore, the action would cause an insignificant effect on this PBF.

2.11.2 Port Townsend Harbor, Keystone Harbor, and Swinomish Navigation Channels

As described above at 2.4, listed fish and sea turtles must be within 300 feet of dredging activities to be potentially exposed to any of the stressors identified above. Based on the locations of these three channels deep within the Puget Sound, it is highly unlikely that any salmon from the Columbia or Willamette Rivers, as well as any sea turtles identified above in Table 2 would occur close enough to be exposed to any action-related stressors. Similarly, based on the absence of rockfish-supportive habitat resources in or adjacent to any of these sites, it is highly unlikely that PS/GB bocaccio and/or PS/GB yelloweye rockfish would be exposed to any action-related stressors. Because the harbors at Port Townsend and Keystone are highly enclosed, and because all three channels are spatially separated from the nearest chum salmon spawning streams, it is discountable that adult Hood Canal Summer-run chum salmon would approach close enough to any of these harbors to be exposed to action-related stressors capable of causing detectable effects.

At most, whale-detectable levels of dredging-related noise (above 120 dB_{RMS}) may radiate up to 1.4 miles (2,200 m) from the entrance of any of these channels. The actual range of acoustic effect would likely be much less than predicted because the high levels of ambient noise that are typically present in the Puget Sound would act to quickly mask project-related noise. Should any whales approach close enough to hear project related noise, the exposure would, at most, cause brief periods of low-level acoustic masking (virtually undetectable against the ambient noise in the area, and temporary avoidance of the area immediately around the channel entrances. The areal avoidance would not hinder migration through the action area, or limit access to important habitat resources. Therefore, the exposure would cause no meaningful effect on the exposed individuals. Based on the information presented above in section 2.4.2, impacts on prey resources would cause no detectable effects in prey species for any of the species considered here

The planned dredging at these channels is not likely to adversely affect critical habitat that has been designated for PS/GB yelloweye rockfish and SR killer whales. The essential PBF of these critical habitats are listed below. This assessment considers the intensity of expected effects in terms of the change they would cause in affected PBF 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.

PS/GB yelloweye rockfish critical habitat is limited to substrates at depths greater than 98 feet (30 m) and waters above that substrate. That habitat occurs beyond the expected range of potential effects from the proposed action. Therefore, it is highly unlikely that the action would cause any detectable effect on any PBF of this critical habitat.

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

1. <u>Water quality to support growth and development</u>
   Continued maintenance dredging would cause ephemeral minor effects on water quality. It would cause no measurable changes in water temperature and salinity. The presence of detectable levels of contaminants, including suspended sediments and reduced DO would be so ephemeral, infrequent, localized, and of such low concentrations that changes in water quality would cause insignificant effects on this PBF.
2. <u>Prey species of sufficient quantity, quality, and availability to support individual growth, reproduction, and development, as well as overall population growth</u>
   Continued maintenance dredging will cause long-term minor effects on prey. It would periodically remove benthic organisms and maintain previously altered habitats at reduced levels of organism abundance and altered populations as compared to undisturbed areas. As described above, the larvae of some benthic organisms are prey resources for salmon that themselves are prey for SR killer whale. However, benthic impacts are not likely to adversely affect salmon, and exposure to reduced water quality would cause no population-level effects on salmon. Therefore, the action would cause insignificant effects on this PBF.
3. <u>Passage conditions to allow for migration, resting, and foraging</u>
   Continued maintenance dredging would cause ephemeral minor effects on passage conditions. Detectable levels of dredging-related noise may radiate up to 1,490 yards around the entrance channels. Exposure to this noise would, at most, cause brief episodic periods of low-level acoustic masking (virtually undetectable against the ambient noise in the area, and avoidance of the area immediately around the channel entrances that would not hinder migration through the action area, or limit access to important habitat resources. Therefore, the action would cause insignificant effects on this PBF.

<u>2.11.3 Everett Harbor/Snohomish River and Upper Duwamish Waterway Navigation Channels</u>

As described above at 2.4, listed fish and sea turtles must be within 300 feet of dredging activities to be potentially exposed to any of the stressors identified above. Based on the locations of these two channels deep within the Puget Sound, it is highly unikely that any salmon from the Columbia or Willamette Rivers, as well as any sea turtles identified above in Table 2 would occur close enough to be exposed to any action-related stressors. Similarly, based on the absence of rockfish-supportive habitat resources in or adjacent to either of these sites, it is highly unlikely that PS/GB bocaccio and/or PS/GB yelloweye rockfish would be exposed to any action-related stressors. Because these channels are spatially separated from the nearest Hood Canal Summer-run chum salmon spawning streams, it is highly unlikely that adult Hood Canal Summer-run chum salmon would approach close enough to either of these channels to be exposed to action-related stressors capable of causing detectable effects.

At most, whale-detectable levels of dredging-related noise (above 120 dB_{RMS}) may radiate up to 1.4 miles (2,200 m) from dredging in these channels. The actual range of acoustic effect would likely be much less than predicted because the high levels of ambient noise that are typically present in the Puget Sound would act to quickly mask project-related noise. Should any whales approach close enough to hear project related noise, the exposure would, at most, cause brief periods of low-level acoustic masking (virtually undetectable against the ambient noise in the area, and temporary avoidance of the area immediately around the channel entrances. The areal avoidance would not hinder migration through the action area, or limit access to important habitat resources. Therefore, the exposure would cause no meaningful effect on the exposed individuals. Based on the information presented above in section 2.4.2, impacts on prey resources would cause no detectable effects in prey species for any of the species considered here.

The planned dredging at these channels is not likely to adversely affect critical habitat that has been designated for SR killer whales. The essential PBF of that critical habitat are listed below. This assessment considers the intensity of expected effects in terms of the change they would cause in affected PBF 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.

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

<u>Water quality to support growth and development</u>

Continued maintenance dredging would cause ephemeral minor effects on water quality. It would cause no measurable changes in water temperature and salinity. The presence of detectable levels of contaminants, including suspended sediments and reduced DO would be so ephemeral, infrequent, localized, and of such low concentrations that changes in water quality would cause insignificant effects on this PBF.

<u>Prey species of sufficient quantity, quality, and availability to support individual growth, reproduction, and development, as well as overall population growth</u>

Continued maintenance dredging will cause long-term minor effects on prey. It would periodically remove benthic organisms and maintain previously altered habitats at reduced levels of organism abundance and altered populations as compared to undisturbed areas. As described above, the larvae of some benthic organisms are prey resources for salmon that themselves are prey for SR killer whale. However, benthic impacts are not likely to adversely affect salmon, and exposure to reduced water quality would cause no population-level effects on salmon. Therefore, the action would cause insignificant effects on this PBF.

Passage conditions to allow for migration, resting, and foraging

Continued maintenance dredging would cause ephemeral minor effects on passage conditions. Detectable levels of dredging-related noise may radiate up to 1,490 yards around the entrance channels. Exposure to this noise would, at most, cause brief episodic periods of low-level acoustic masking (virtually undetectable against the ambient noise in the area, and avoidance of the area immediately around the channel entrances that would not hinder migration through the action area, or limit access to important habitat resources. Therefore, the action would cause insignificant effects on this PBF.

2.11.4 Conclusion

For the reasons expressed immediately above, NMFS concurs with the COE's determination that the proposed action is not likely to adversely affect ESA-listed salmon from the Columbia and Willamette River species, and their designated critical habitats; HCSR chum salmon; PS/GB bocaccio, PS/GB yelloweye rockfish, and its designated critical habitat; any of the seven the ESA-listed marine mammals; designated critical habitat for SR killer whales; any of the four ESA-listed marine turtles; and designated critical habitat for leatherback turtles, as identified above in Table 2.

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

Section 305(b) of the MSA directs Federal agencies to consult with NMFS on all actions or proposed actions that may adversely affect essential fish habitat (EFH). The MSA (section 3) defines EFH as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." Adverse effect means any impact that reduces quality or quantity of EFH, and may include direct or indirect physical, chemical, or biological alteration of the waters or substrate and loss of (or injury to) benthic organisms, prey species and their habitat, and other ecosystem components, if such modifications reduce the quality or quantity of EFH. Adverse effects on EFH may result from actions occurring within EFH or outside of it and may include site-specific or EFH-wide impacts, including individual, cumulative, or synergistic consequences of actions (50 CFR 600.810). Section 305(b) also requires NMFS to recommend measures that can be taken by the action agency to conserve EFH.

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

3.1 Essential Fish Habitat Affected by the Project

The proposed action and action area for this consultation are described in section 1 of this document. The action area includes areas designated as EFH for various life-history stages of Pacific Coast Salmon, Pacific Coast Groundfish, and Coastal Pelagic Species. The PFMC described and identified EFH for Pacific coast groundfish (PFMC 2005), Pacific salmon (PFMC 2014), and coastal pelagic species (PFMC 1998). In addition, estuarine habitats within the action area are considered a habitat area of particular concern (HAPC).

3.2 Adverse Effects on Essential Fish Habitat

The ESA portion of this document describes the adverse effects of this proposed action on ESA-listed species and critical habitat, and is relevant to the effects on EFH for Pacific Coast Salmon, Pacific Coast Groundfish, and Coastal Pelagic Species. Based on the analysis of effects presented in Sections 2.4.1 through 2.4.3, the Corps' project will cause small scale adverse effects on this EFH through direct or indirect physical, chemical, or biological alteration of the water or substrate, and through alteration of benthic communities, and the reduction in prey availability. Therefore, we agree with the Corps effects determination that the proposed action would adversely affect the EFH identified above.

3.3 Essential Fish Habitat Conservation Recommendations

Implementation of the following conservation recommendations would minimize and/or avoid adverse effects on EFH for Pacific Coast Salmon, Pacific Coast Groundfish, and Coastal Pelagic Species that are likely to result from the proposed action.

1. To reduced adverse alteration of substrate and forage abundance:
    a. Require compliance with the BMPs for this project (Appendix 1);
    b. Confine the dredge prism to the minimum area necessary, and within the current official federal channel boundaries;
    c. Limit sediment removal to the minimum necessary to achieve project goals; Maintain/maximize draghead and/or cutterhead contact with the substrate while pumps are operating; and
    d. Return any logs, root wads, or other woody debris that are removed during dredging to the watershed from which they were taken.

2. To reduce adverse alteration of water quality:
    a. Limit dredging to areas that meet the DMMP guidelines for sediment suitability for unconfined aquatic disposal in the marine environment;
    b. Require compliance with the WQMP for this project (Appendix 2); and
    c. Require dredge operators to stop dredging when turbidity exceeds 10 NTU above background levels of 50 NTU or less, or exceeds 20% above background levels that are more than 50 NTU at 1,200 feet from dredging and/or sediment disposal in Grays Harbor, and 600 feet for all other channels. Dredging may only resume after turbidity levels return to compliant levels identified in Appendix 2 or the current WDOE WQMP if it is more restrictive.

3.4 Statutory Response Requirement

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

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

3.5 Supplemental Consultation

The 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 user of this Opinion is the COE. Other users could include King County River and Floodplain Management Section, WDFW, and the citizens of King County. Individual copies of this Opinion were provided to the COE. 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.

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Appendix 1

U.S. Army Corps of Engineers Standard Best management Practices For Dredging Operations

December 18, 2017

Section 7(a)(1) of the ESA directs Federal agencies to use their authorities to further assist the purposes of the ESA by carrying out conservation programs for the benefit of the threatened and endangered species. The USACE has developed a list of Standard Best management Practices (BMP and conservation measures and incorporated these into the routine maintenance dredging program to reduce environmental impacts of dredging to ESA-listed species. These measures appear below:

1. USACE dredging projects are limited to specific authorized dimensions and are executed within the authority for each project.

2. USACE conducts dredging operations during the project's prescribed work window(s). If this cannot be done due to extenuating circumstances, then the USACE will notify the Services and re-consult if necessary.

3. USACE maintenance dredging is conducted based on the results of site-specific hydrographic condition surveys conducted for each dredging event.

4. USACE obtains a suitability determination of the sediment following DMMP protocols for sediment disposal and places material at the appropriate designated disposal sites. Material determined unsuitable for open-water disposal is disposed at appropriate upland sites.

5. USACE coordinates dredging projects with the local Indian Tribes that have usual and accustomed fishing rights in each project area.

6. Dredging projects are managed by USACE construction management Standard Operating Procedures, which are employed and enforced by Construction Oversight Representatives.

7. Clamshell dredging operations are conducted in a manner that minimizes spillage of sediments from the dredge bucket and transport barge.

8. Hopper and hydraulic pipeline dredges limit, to the extent possible, pumping activities to when the suction equipment is on the substrate. In general, pump operations start after the equipment is on the substrate. When hoppers are full or dredging is interrupted, the equipment is lifted off the surface long enough to flush the remaining sediment from the pipes and then pumping is stopped.

9. Once the material has been removed, the material will not be dumped back into the water, except into an appropriate disposal or beneficial use site.

10. Barges used to transport the dredged material to the disposal or transfer sites will not be filled beyond their capacity and will completely contain the dredged material.

11. USACE requires bottom dump barges to be equipped with electronic monitoring systems that record the barge's location and operations when in transport and during disposal.

12. USACE requires barge operators to maintain the seals on the bottom dump barges to minimize loss of sediment.

In addition to the standard dredging BMP listed above, the USACE may apply additional conservation measures, where conditions warrant, to minimize harm to species of concern. Some examples include the following:

- USACE will use a clamshell (mechanical) dredge, where project requirements allow this equipment, to minimize the possibility of entraining or otherwise harming ESA-listed species.

- During project planning phase, USACE will coordinate with WRIA groups and other local restoration/stewardship groups to identify individual and long-term opportunities for beneficial use of dredged material. If beneficial use opportunities are identified, and funds are available, then the USACE will consult with the Services on the beneficial use opportunities.

Appendix 2

Water Quality Monitoring Plan For Maintenance Dredging of Federal Navigation Channels at Grays Harbor, Westhaven Cove, Quillayute River, Port Townsend Harbor, Keystone Harbor, Swinomish Channel, Everett Harbor and the Snohomish River, and the Upper Duwamish Waterway

December 22, 2017

The maintenance dredging program considered in this Opinion must comply with State-mandated water quality monitoring plans (WQMPs) that are periodically reissued and updated for the specific dredging sites, pursuant to State of Washington 401 Water Quality Certification (WQC) and Coastal Zone Management Act (CZMA, October 10, 2017), Washington Administrative Code (WAC) 173-201A-200 (2011), and WAC 173-201A-210 (2011).

Because this Opinion covers 25 years of maintenance dredging, there is no guarantee that the State WQMPs for the eight sites considered in this Opinion will remain unchanged over the life of this consultation. Therefore, the WQMP described below is based upon the most current State WQMPs, with the understanding that this plan would likely reflect future State-required measures. If State-mandated measures are changed in the future, the more restrictive of the measures shall apply for this maintenance dredging program.

At a minimum, the COE shall comply with the following WQMP, with an additional condition at Step 3 of the Exceedance Protocol, in that dredging and/or in-water disposal shall halt if turbidity exceeds the NTU limits identified below at ranges equal to twice the State Points of Compliance (POC), and shall not resume until turbidity levels return to compliant levels. It is important to note that the Corps and the dredge operators are expected to make every reasonable effort to ensure that turbidity remains compliant within the State POC.

<u>Constituents Monitored</u>

- Aquatic life turbidity applicable criteria:
  - Point of Compliance (POC)
    - POC is 600 feet from the activity in Grays Harbor
    - POC is 300 feet from the activity in all other channels
  - Turbidity readings at the POC shall not exceed 10 NTU (nephelometric turbidity units) over background when the background is 50 NTU or less, or a 20 percent increase in turbidity when the background turbidity is more than 50 NTU."
  - Visual turbidity anywhere at or past the POC from the activity and/or the disposal location shall be considered a possible exceedance of the standard and shall be verified through measured turbidity sampling.

Frequency of Monitoring

- The contractor's dredging equipment shall operate for at least one hour prior to the collection of turbidity readings to ensure readings and observations are representative of water quality conditions during active operations.
- The contractor's water quality monitoring will correspond with; 1) slack tide and 2) ebb or flood tidal conditions to the extent these times adequately reflect periods of active dredging and occur during daylight hours.
- The contractor shall monitor for turbidity, instrument measured and visual, during daily dredging activities during daylight hours:
  - Take and record readings twice daily at one (1) up-current and three (3) down-current locations the first five (5) consecutive days of dredging, assuming no exceedances.
  - Record visible turbidity down-current of the point of compliance recorded at each reading collected at the point of compliance the first five (5) consecutive days of dredging, assuming no exceedances.
  - Take and record readings once a day along a transect across the navigation channel at the point of compliance the first five (5) consecutive days of dredging, assuming no exceedances.
  - Record visible turbidity within the disposal area for every disposal action during daylight hours the first five (5) consecutive days of dredging and disposal, assuming no exceedances.
  - No monitoring shall occur before sunrise or after sunset unless authorized by the Corps.
- Upon completion of the instrument measured monitoring days, the contractor shall send the monitoring data report daily to the Corps within 24 hours of completion of monitoring activity.
  - If there are no exceedances in water quality within the five (5) consecutive days, the contractor shall discontinue instrument monitoring, unless otherwise directed by the Corps, if required by WA Ecology.
  - If there are exceedances in water quality within the five (5) consecutive days, the contractor shall continue monitoring following the steps listed in "Exceedances and Exceedances Protocol."
- The contractor shall continue to monitor and record (written) daily visual turbidity monitoring at the dredging Point of Compliance and at the disposal site during every disposal event every day (daylight hours only) the dredge is in operation. At any point, if visual monitoring indicates a turbidity plume, the contractor shall take a physical reading to confirm/verify if an exceedance has occurred. If an exceedance is confirmed/verified through physical monitoring, the exceedance protocol listed below shall be followed.

Sampling Approach

- The contractor shall establish water quality conditions according to the following:

- The contractor shall measure turbidity with a meter (HydroLab or similar), starting at least one hour after the dredging equipment has been operating, to ensure readings and observations are reflective of conditions during active operations.
- The contractor shall verify the calibration of the meter and calibrate as necessary with standardized samples prior to the start of each day's monitoring, per the manufacturer's specifications.
- The contractor shall collect readings within the water strata:
  - near the surface (~ 2 feet below)
  - mid-depth
  - near the bottom (~2 feet above)

❖ The contractor shall compare water quality readings taken at the point of compliance to background levels within the water column strata (i.e., surface level at points of compliance compared to surface level at background stations) to determine compliance with constituent standards.

❖ The contractor shall visually observe turbidity during daylight hours beyond the point of compliance and record the findings at the same time the turbidity levels are measured.

❖ The contractor shall visually observe turbidity within the disposal area and record the findings every disposal action during daylight hours.

<u>Monitoring Locations</u>

❖ The area of mixing point of compliance for turbidity during dredging is 600 feet down current from the point of dredging and thus will move as the dredging progresses.

❖ The contractor shall establish Monitoring Points at:

- Measured Background: A minimum of 200 feet up current from the dredging.
- Measured Downstream Early Warning – 300 feet down current of the dredging.
- Measured Downstream Point of Compliance – 600 feet down current of the dredging.
- Measured Downstream Proposed Point of Compliance – 1,200 feet down current of the dredging.
- Visual Downstream of Point of Compliance - visual turbidity observed beyond 600 feet down current of the dredging will be recorded at the same time the turbidity levels are measured.

  ❖ The contractor shall establish channel transect Monitoring Points across the navigation channel located at the Point of Compliance. This transect shall be:

- Monitored once per day.
- Located at a minimum of three (3) points spaced roughly equidistant across the navigation channel.
- Collect three (3) readings within the water strata; 1) just below the surface (~ 2 feet below), 2) mid-depth, and 3) near the bottom (~2 feet above).

- ❖ The contractor shall observe and record visible turbidity within the disposal area for every disposal action during daylight hours.
- ❖ A map sample locations will be included in the final plan, which will be developed by the dredge contractor.

<u>Elevations at the Early Warning and Extended Point Locations</u>

- ❖ If measurements taken at the Early Warning and/or Extended Point locations show recorded turbidity is greater than 10 NTU over background where the background is less than 50 NTU, or if more than a 20 percent increase in turbidity when the background turbidity is more than 50 NTU, that sample is recorded as an ELEVATION. Assuming dredging continues, the contractor shall continue to monitor per the protocol below:
  - o Review existing BMPs, including, but not limited to:
    - Check the seal on the bucket, remove any obstructions, repair/replace bucket if point of closure does not fully close
    - Do not overfill bucket – only fill to bucket's capacity
    - Slow speed of lifts from bottom to surface and swing from surface to barge
    - Do not allow water in barge to excessively overtop
  - o Evaluate potential new BMPs.

<u>Exceedances and Exceedance Protocol</u>

- ❖ If measurements taken at the Point of Compliance or in the disposal site show recorded turbidity are greater than 10 NTU over background where the background is less than 50 NTU, or if more than a 20 percent increase in turbidity when the background turbidity is more than 50 NTU, that sample is recorded as an EXCEEDANCE. Assuming dredging continues, the contractor shall continue to monitor per the exceedance protocol below:
  - o *Step 1: Verification of the problem*
    - If monitoring indicates an exceedance, the contractor shall collect, within ten (10) minutes of the initial reading, another series of readings (~ 2 feet below), mid-depth, and near the bottom (~2 feet above) in the same location.
    - If the exceedance still exists, the contractor shall photograph conditions at the point of compliance and then collect another series of readings at the nearest up-current background station to determine if the exceedance is caused by the dredging and disposal or by a change in background conditions (for example due to a heavy rainfall event).
    - The contractor shall notify the Corps by telephone within 30 minutes after there has been a measured confirmed exceedance.
    - The Corps will direct the contractor to implement best management practices (BMPs), as appropriate and applicable, to reduce turbidity. Example BMPs include, but not limited to:

- ✓ Check the seal on the bucket, remove any obstructions, repair/replace bucket if point of closure does not fully close
- ✓ Do not overfill bucket – only fill to bucket's capacity
- ✓ Slow speed of lifts from bottom to surface and swing from surface to barge
- ✓ Do not allow water in barge to excessively overtop

- In the event of exceedances such that dredging is temporarily stopped by the Contracting Officer during the five (5) consecutive days of monitoring, the Corps will consult with WA Ecology and five (5) additional consecutive days monitoring will be required with no exceedances in order to discontinue monitoring.

o *Step 2: Increased monitoring*

- The contractor shall collect another reading no more than one (1) hour after the exceedance is recorded to verify the dredging operation has been altered to reduce the exceedance to within acceptable limits.
- If this second reading, taken 1 hour later, still shows an exceedance, the contractor shall immediately notify the Corps by telephone that there is still a measured exceedance.
- The Corps will again direct the contractor of the situation and require the contractor take all measures possible to reduce turbidity.
- Finally, the contractor shall collect a third reading, taken no more than two (2) hours after the first exceedance is recorded.
- Contractor shall notify Corps that a reportable exceedance occurred, the reason for the exceedance, as well as BMPs to prevent reoccurrence, and provide documentation from the incident to the Corps to forward to WA Ecology.

o *Step 3: Stop dredging or disposal*

- If a reading, taken two (2) hours after the initial exceedance, still shows an exceedance, the contractor shall notify the Corp immediately. The Corps will notify WA Ecology of the situation. The Contracting Officer may order the contractor to stop dredging.

o *Step 4: Continued sampling until compliance is achieved, assuming dredging continues*

- ❖ If an exceedance is confirmed, monitor every 2 hours until sunset or until two consecutive readings that do not exceed standards.
- ❖ Return to twice per day for 5 consecutive days of no further exceedances.
- The Corps will again direct the contractor to take all measures possible to reduce turbidity.
- The contractor shall resume the normal schedule of water quality monitoring as per specific requirements above until directed by the Corps to cease monitoring.

o *Step 5: Resuming dredging after dredging has been stopped*

- After the contractor has stopped dredging, the contractor shall collect readings at hourly intervals until sunset and resume the following morning until water quality levels return to background.
- Once compliance has again been achieved, the Contracting Officer will order the contractor to resume dredging.
- The Corps will provide monitoring data to WA Ecology and notify WA Ecology that dredging has resumed.
- Once dredging has resumed, the contractor will return to twice a day for 5 consecutive days of water quality monitoring required above, which shall become the responsibility of the contractor.
- The contractor shall continue the normal schedule of water quality monitoring as per specific requirements above until directed by the Corps to cease monitoring.

Reporting

- ❖ The Corps will report exceedances, including potential causes and BMPs to prevent reoccurrence, and/or dredging shut downs to WA Ecology by telephone and email as soon as is practicable, but within 24 hrs.
- ❖ The contractor shall document any dredging shut downs with an Incident Report, which will be transmitted to the Corp by email and through the QCS/RMS system within 24 hours of the exceedance.
- ❖ The Incident Report shall document all exceedances and will include the date, time, location, activity, turbidity data collected, name of person collecting the data, names of persons notified of the exceedance, photographs if taken, and summary of how the exceedance was resolved following the above protocol.
- ❖ The Incident Report shall be sent to WA Ecology within five (5) days of the exceedance, per the 401 Certification.
- ❖ WA Ecology will require the restart of the five (5) consecutive days of instrument measured turbidity monitoring, which shall be the responsibility of the contractor, until compliance is achieved.
- ❖ Weekly turbidity (visual or measured) reporting is required to be sent to WA Ecology, per the 401 Certification.
- ❖ Within 60 days of termination of the dredging and disposal activities, the Corps will submit a summary report of the measured turbidity results to WA Ecology.

Responsibility and Communication Plan

- ❖ The Corps will oversee turbidity monitoring conducted by the contractor.
- ❖ The Corps will be responsible for coordinating with WA Ecology and submitting the Turbidity Monitoring Reports and data provided by the contractor.
- ❖ The Corps will notify WA Ecology within 24 hours if an exceedance occurs.
- ❖ The Corps will coordinate with the dredging contractor.

- ❖ The contractor shall provide Turbidity Monitoring Report and data to the Corps, as directed.
- ❖ The contractor shall notify the Corps within 2 hours if a confirmed exceedance occurs.
- ❖ The contractor POC will be provided in the Contractor Water Quality Monitoring Plan.
- ❖ The Corps Points of Contact for turbidity monitoring will be First Last, Project Manager (206-XXX-XXXX), and Joanne Gardiner, Environmental Coordinator (206-764-6878).
- ❖ The WA Ecology Point of Contact is First Last, Federal Permit Coordinator, (360-XXX-XXXX).
- ❖ Official reporting of any incidents are to be sent to both the WA Ecology Point of Contact AND to the fednotification@ecy.wa.gov inbox.