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

Refer to NMFS No:
WCRO-2019-04086

June 29, 2022

Todd Tillinger
Chief Regulatory Branch
U.S. Army Corps of Engineers, Seattle District
4735 East Marginal Way South, Bldg. 1202
Seattle, Washington 98134-2388

Re: Endangered Species Act Section 7(a)(2) Biological Opinion, and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response for the Salish Sea Nearshore Programmatic Consultation (SSNP)

Dear Mr. Tillinger:

Please find below the Endangered Species Act Section 7(a)(2) Biological Opinion, and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response for the Salish Sea Nearshore Programmatic Consultation (SNNP).

In this opinion, we conclude that the proposed programmatic action is not likely to jeopardize the continued existence of Puget Sound (PS) Chinook salmon (*Oncorhynchus tshawytscha*), Hood Canal summer-run (HCSR) chum (*O. keta*), PS steelhead (*O. mykiss*), Puget Sound/Georgia Basin (PSGB) yelloweye rockfish (*Sebastes ruberrimus*), PSGB bocaccio (*S. paucispinis*), or Southern Resident killer whales (SRKW) (*Orcinus orca*), and will not result in the destruction or adverse modification of their critical habitats. Further, in this opinion we concluded that the proposed action is not likely to adversely affect the Central America or Mexico humpback whales (*Megaptera novaeangliae*), the southern DPS of green sturgeon (*Acipenser medirostris*), the southern distinct population segment (DPS) of eulachon, (*Thaleichthys pacificus*) or critical habitat for the southern distinct population segment (DPS) of eulachon.

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

Sincerely,

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

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

Salish Sea Nearshore Programmatic

NMFS Consultation Number: WCRO-2019-04086

Action Agency: U.S. Army Corps of Engineers

Affected Species and NMFS' Determinations:

ESA-Listed Species	Status	Is Action Likely to Adversely Affect Species?	Is Action Likely to Jeopardize the Species?	Is Action Likely to Adversely Affect Critical Habitat?	Is Action Likely to Destroy or Adversely Modify Critical Habitat?
Puget Sound Steelhead	Threatened	Yes	No	Yes	No
Puget Sound Chinook salmon	Threatened	Yes	No	Yes	No
Hood Canal Summer-run Chum salmon	Threatened	Yes	No	Yes	No
Puget Sound/Georgia Basin Yelloweye Rockfish	Threatened	Yes	No	Yes	No
Puget Sound/Georgia Basin Bocaccio	Endangered	Yes	No	Yes	No
Eulachon, Southern DPS	Threatened	No	N/A	No	N/A
Green Sturgeon, Southern DPS	Threatened	No	N/A	No	N/A
Southern Resident Killer whale *(Orcinus area)*	Endangered	Yes	No	Yes	No
Humpback Whale Central American DPS *(Megaptera novaeangliae)*	Endangered	No	N/A	No	N/A
Humpback Whale Mexico DPS *(Megaptera novaeanrliae)*	Threatened	No	N/A	No	N/A

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

Consultation Conducted By: National Marine Fisheries Service
West Coast Region

Issued By:

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

Date: June 29, 2022

WCRO-2019-04086

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1. INTRODUCTION

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

1.1. Background

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

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

For many years, NMFS has completed programmatic ESA and EFH consultations to address collections of routine activities that may affect listed species and critical habitat in the Pacific Northwest. These programmatic consultations have addressed activities such as habitat restoration, transportation projects such as road-stream crossing improvement, and construction, replacement, or repair of over-water structures. The activity categories covered by programmatic consultations must be clearly described and their implementation subject to specific design criteria such that their aggregate effects are predictable. Otherwise, NMFS cannot do a meaningful analysis to support conclusions made in these programmatic consultations. Indeed, with all consultations, NMFS must be able to reliably ascertain effects but, with programmatic consultations, the fact that we do not know the site-specific details of all the activities that will occur, makes it especially important that the parameters of the programmatic are clear and well understood, i.e., what falls within the action and what does not. That clarity allows us to reliably predict and then analyze the effects of activities that fall within the covered activity categories.

During development of programmatic consultations, NMFS typically works with the action agency, providing technical assistance on the development of the specific design criteria for the covered activity categories. These design criteria function to describe and limit the activities and their effects to those that are well understood and predictable and thus allow for a meaningful analysis. The design criteria are what make the programmatic suite of activities amenable to ESA consultation.

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

1.2. Consultation History

In 2019, NMFS and the US Fish and Wildlife Service (USFWS) began working with the Corps of Engineers, Seattle District (Corps) to identify a set of routine activities within the Salish Sea that could be covered under a programmatic consultation. This consultation is referred to as the Salish Sea Nearshore Programmatic (SSNP). It soon became apparent that further interagency resolution would be warranted for NMFS and the Corps to address how the Corps Regulatory Program reviews a proposed proponent's request for discharges or work associated with existing structures under Section 7 of the Endangered Species ESA in order to proceed with this programmatic consultation.

A *Memorandum Between the Department of the Army (Civil Works) and the National Oceanic and Atmospheric Administration* (NOAA) (Joint Memo), dated January 5, 2022, provided a basis to resolve the issue and prompted both agencies to resume work on SSNP. On January 7, 2022, NMFS and the Corps resumed development of SSNP consistent with the Joint Memo and existing legal requirements. USFWS re-joined the effort shortly thereafter, and the consulting agencies, in cooperation with the Corps, agreed to develop aligned, but independent, programmatic consultations based on the same proposed action that would each streamline the ESA consultation process for activities regulated by the Corps in the Salish Sea nearshore area.

During development of the proposed action, the NMFS and the Corps exchanged drafts of the proposed action and provided each other feedback. On April 8, 2022, NMFS, USFWS, and the Corps agreed on a programmatic action for the Salish Sea Nearshore Programmatic Consultation (SSNP).

On April 11, 2022, we received a request from the Corps to initiate formal consultation on SSNP. The action agency determined that activities carried out under SSNP may affect and are likely to adversely affect the following listed species and their critical habitats:

1. Puget Sound (PS) Chinook salmon (*Oncorhynchus tshawytscha*)
2. Hood Canal summer-run (HCSR) chum salmon (*O. keta*)
3. PS steelhead (*O. mykiss*)
5. Puget Sound/Georgia Basin (PSGB) yelloweye rockfish (*Sebastes ruberrimus*)
6. PSGB bocaccio (*S. paucispinis*)
7. Southern Resident Killer Whales (SRKW) (*Orcinus orca*)

The Corps determined that the SSNP proposed action is not likely to adversely affect two distinct population segments of humpback whales, and southern DPS of green sturgeon (*Acipenser medirostris*), and critical habitat for green sturgeon. Upon further consultation with the Corps, it was determined that the proposed action is not likely to adversely affect the DPS of eulachon, (*Thaleichthys pacificus*) and critical habitat for eulachon.

As part of the consultation process, from April 11 to June 23, 3, 2022, the Corps, NMFS, and USFWS made minor revision to the proposed action for SNNP. A general construction measure was added for rescuing listed fish within areas isolated for in-water work. Criteria were added for placement of spawning material for forage fish. NMFS shared a draft of this opinion with the Corps and USFWS on multiple occasions throughout the process.

1.2.1 Estimating the Projected Level of Future Activity under SSNP

To estimate the number and type of activities expect to be carried out under SSNP, we relied on information: (1) provided in the Corps' request for formal consultation (Table 1); (2) from individual consultation requests received by NMFS from August 1, 2020 to August 1, 2021 for a subset of projects that would have qualified for coverage under SSNP (referred to as "pending consultations"); (3) on projects implemented under our programmatic consultation on the Corps Seattle District Regional General Permit #6 from May 2017 to December 2019[1] (the period covered by the Corps most recent monitoring report)(referred to as "RPG-6); and (4) on projects covered by three batched NMFS biological opinions on projects in the nearshore of Puget Sound (referred to as "batched" or "batches").[2] Of the pending consultations, 46 percent involve residential projects, 16 percent are municipal projects, and 38 percent address commercial projects.

We conducted a variety of analyses on the above data to determine the level of activity expected under SSNP. For example, we looked at four activity types, included as part of the proposed action for this programmatic consultation, from data sets 2-4: shoreline armoring, piles, overwater and in-water structures, and dredging (Table 2). Some projects included multiple activity types. The projects were then sorted by year, either by the date a consultation request was received (i.e., the consultation has been requested but not completed) or date the consultation was completed. Data sets from 2-4 above were considered individually and also added together to create combinations that could reflect the likely level of activity expected under SSNP in the future.

To further understand the level of activity expected under SSNP, more specific information was collected for each of the projects in data sets 2-4: (1) Linear feet of shoreline armoring; (2) number of piles repaired, replaced, or installed, (3) square footage of overwater and in-water structures repaired, replaced, or installed; and (4) cubic yards of material dredged (Table 3). This information gives a more accurate indication of the level of activity expected and resulting impacts on listed species and critical habitat as opposed to a simple number of projects.

After examining the more specific information (Table 3) from individual data sets and combination of data sets, the "pending consultations + RGP-6" combination was selected as most likely to reflect the expected level of activity under SSNP. This data set represents a complete year's worth (August 2020-August 2021) of consultation requests for actions that did not qualify for our RGP-6 programmatic consultation plus the residential pier, ramp, and float projects that did qualify for RGP-6. The projects that did not qualify for RGP-6 were generally port, marina, or infrastructure projects or residential projects that included shoreline armoring (our programmatic consultation on RGP-6 did not include shoreline armoring). The proposed action for SSNP covers all of these types of projects and activities, so adding these data sets together gives a reasonable place to begin a prediction of the level of activity expected under SSNP in the future. The "batched + RGP-6" was also considered, but in some years covered by this data set, such as 2018, we completed some individual consultations, so that year's data does

[1] These projects are repair, replacement of existing, or installation of new residential pier, ramp, and floats.
[2] Consultation requests for projects covered under the three batched biological opinions were received between May 1, 2018, and July 30, 2020.

not include some projects that would have otherwise been included in that data set. We have not completed consultation on any of the projects in the "pending consultations" data set, so this set represents the most accurate prediction of a year's worth of activity.

While "pending consultations + RGP-6" provides an accurate number of projects in the prior recent period, it is unlikely to fully predict the number of projects in any future year, given the growing human population in the Salish Sea area. The human population and level of development in the Salish Sea area of Washington State is increasing.[3] We also expect the passage of the Infrastructure Investment and Jobs Act (P.L. 117-58) to increase funding for projects, which would likely be authorized under SSNP in the future. To accommodate this expected increase in level of activity, we multiplied the information on specific levels of activity (Table 3) by a factor of 1.25. There is a lack of information available to specifically predict the future increase in activity, but a 25 percent increase is a reasonable estimate based on an expected increases in funding and population growth in the action area. If the level of activity increases beyond this amount, the Corps can reinitiate consultation or request individual consultations instead of using SSNP. The final metric used to predict the level of activity expected under SSNP is "pending consultations +RGP-6" X 1.25 (Table 3). This level of activity was used to complete our analysis of effects of the proposed action and to develop indicators (or surrogates) of the extent of incidental take (Section 2.9.1).

The analysis supporting the level of activity in Table 3 is based on pending projects that NMFS received as individual consultation requests, without any anticipated offsets they may propose as required by SSNP's proposed action. Thus, in addition to the effects identified above, we expect more than 30 offsetting projects (as identified in Table 1) will likely be covered under PDC 11, 12, and 13. We discuss the effects of these activities in detail below, but in general we expect that conservation offsetting projects will have short-term adverse impacts due to construction (i.e., suspended sediment, noise from pile driving and removal, and re-suspended contaminants), but all long-term effects would be beneficial.

Table 1. Estimated number of Corps permits issued annually by PDC type that could be eligible for coverage under SSNP submitted by Corps to NMFS (information is from the Corps' request for formal consultation).[4]

Project Design Criteria (PDC) For Covered Activities	Corps' estimated number of Corps permits that could use SSNP coverage annually
PDC #1	16
PDC #2	6
PDC #3	4
PDC #4	6
PDC #5	79
PDC #6, PDC #7	132
PDC #8	16

[3] See: https://www.ofm.wa.gov/sites/default/files/public/dataresearch/pop/april1/ofm_april1_poptrends.pdf (accessed 6/24/2022)
[4] Data was collected for the time period of March 19, 2017 – December 31, 2019. These numbers are estimates and reflect a 5% contingency to address uncertainty or unforeseen circumstances.

Project Design Criteria (PDC) For Covered Activities	Corps' estimated number of Corps permits that could use SSNP coverage annually
PDC #9	5
PDC #10	9
PDC #11, PDC #12, PDC #13	30*
PDC #14	17
Total	**320**

*This number is likely an underestimate as it only accounts for standalone restoration projects recently authorized by the Corps and does not account for activities that may be carried out to achieve conservation offsets under SSNP.

Table 2. Annual number of activity types included in projects in data sets and combination of data sets considered in projecting the level of activity expected under SSNP in the future. OWS= overwater structure, IWS= In-water structure.

Data Set	Shoreline Armoring	Piles	OWS and/or IWS	Dredging
RGP6/Year (May 2017 to December 2019)	0	38	38	0
Batch/Year (May 2018 to July 2020)	14	19	21	2
Batch + RGP6 / Year	14	57	59	2
Pending consultations /Year (August 2020 to August 2021)	21	22	19	3
Pending consultations + RGP6/Year	**21**	**60**	**57**	**3**

Table 3. Annual amount of specific activity types from projects in data sets and combination of data sets considered in projecting the level of activity expected under SSNP in the future. OWS= overwater structure, IWS= in-water structure, LF= linear feet, CY= cubic yards.

Data Set	LF Shoreline Armoring	LF X1.25	# of Piles	Piles X1.25	OWS and IWS (sq ft)	Sq ft X1.25	CY Dredging	CY x1.25	CY X2
RGP6/Year	0	0	323	404	21377	26721	0	0	0
Batch/Year	3018	3772	1672	2090	193148	241435	31646	39558	63293
Batch + RGP6 / Year	3018	3772	1995	2494	214525	268156	31646	39558	63293
Pending consultations /Year	18959	23699	807	1009	153290	191613	26860	33575	53720
Pending consultations + RGP6/Year	**18959**	**23699**	**1130**	**1413**	**174667**	**218334**	**26860**	**33575**	**53720**

As explained further in the Incidental Take Statement of this opinion, we expect greater levels of activity under SSNP for the two years following finalization of this consultation. NMFS has requests for consultation on approximately 100 projects in the nearshore of the Salish Sea that could potentially be covered under SSNP. As a result, we expect the first two years of activity to be approximately double what is expressed in Table 3 as the pending consultations and new projects are covered under SSNP. Since many projects have been delayed due to the number of pending consultations, the level of impact on nearshore habitat over the past two years (2020 and 2021) has been low. The first two years following finalization of SSNP is expected to result in a higher-than-typical number of applicants voluntarily seeking to use SSNP as opposed to continuing to pursue individual consultations. Essentially, the work potentially covered under SSNP for the first two years will represent four years' worth of potential.

1.3. Proposed Federal Action

The Secretary of the Army, acting through the Corps, is responsible for administering a regulatory program (33 C.F.R. Sections 320-332) that prohibits certain activities until permits for certain activities in waters of the United States are obtained, as set forth at 33 C.F.R. 320.2, including, principally, Section 404 of the Clean Water Act (CWA) and Sections 10 of the Rivers and Harbors Act (RHA) of 1899 (33 U.S.C. 403). Under Section 404 of the CWA, the Corps regulates the discharge of dredged or fill material in waters of the United States. 33 CFR 328.3. In freshwater, the limit of jurisdiction is the ordinary high water mark (OHWM) and adjacent wetlands. In tidally influenced waters, the landward limit of the Corps' CWA jurisdiction extends to the high tide line (HTL) and adjacent wetlands. See 33 C.F.R. 328.4. Under Section 10 of the RHA, the Corps regulates structures and/or work in or affecting the course, condition, or capacity of navigable waters of the United States. The shoreward limit of RHA jurisdiction in tidal waters is Mean High Water (MHW). *See* 33 C.F.R. 329.12. The regulatory program for Washington State is administered by the U.S. Army Corps of Engineers, Seattle District.

Under the ESA, "action" means all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by federal agencies (50 C.F.R. 402.02). For purposes of this programmatic consultation, the Action Agency is the Corps, and the activities are those proposed by applicants seeking authorization under the Corps' Regulatory Program.

The SSNP is a program developed by NMFS and the Corps for programmatic ESA and Essential Fish Habitat (EFH) consultation. The programmatic consultations includes a set of activity categories and specifies design criteria for those activities that, when implemented: (1) help avoid and minimize adverse effects of activities that fall in the covered categories on listed species and their critical habitat; (2) provide parameters for eligible activities and their effects to enable the agencies to provide an analysis of the effects of these activities that is predictable and foreseeable; and (3) ensure that activities, authorized or carried out under SSNP, either individually or in total, do not jeopardize the continued existence of species listed under the ESA, or adversely modify their designated critical habitat. The Corps proposes to authorize certain activities under the CWA and RHA where applicants propose activities that fall within SSNP's described activity categories and applicants have agreed to implement their project consistent with the SNNP's applicable design criteria and any other requirements of the Opinion, such as those included in the incidental take statement (ITS).

1.3.1 Activity Categories

A. Activity Categories

Projects covered by SSNP are limited to the categories of activities described in Table 4, provided they comply with the associated project design criteria (PDC) and general construction measures (GCMs). Activities covered include repair, maintenance, and installation of culverts, bridges, utilities, stormwater facilities and outfalls; shoreline modifications; installation, repair, replacement of navigation aids, scientific measurement devices, tideland markers, buoys, and maintenance of in-water or over-water structures (i.e., piers, ramps, floats, boat ramps, etc.); maintenance dredging; and habitat enhancement activities that impact nearshore areas of the Salish Sea and result in effects to ESA listed resources.

The subsections below describe the activities that are proposed as part of this programmatic consultation, including the applicable design criteria. As with some activities requiring Corps permits, projects covered under SSNP often involve elements or activities that are not under Corps' regulatory authority. Other programmatic consultations with the Corps have included design criteria for aspects of the covered projects that are both within the Corps' authority and those that are not under the Corps' authority. This approach reflects the understanding that under the ESA, effects of the action include the effects of other activities that would not occur but for the proposed action under Corps review and are reasonably certain to occur. For purposes of this programmatic consultation, in order for the programmatic suite of activities to have predictability regarding the combined effects of an action and the consequences of that action, certain anticipated aspects of activities that may not be under the jurisdiction of the Corps, are nevertheless limited by design criteria. For example, "but for" the in-water construction project, riparian vegetation removal due to equipment staging would not occur. Therefore, the element of vegetation removal is assumed to be a consequence of the action and is reasonably certain to occur due to the need for equipment staging for purposes of this programmatic consultation. Hence, there is design criteria regarding riparian vegetation removal. The Corps does not regulate activities occurring outside their jurisdictional boundaries under their authority established by the CWA and RHA (i.e., vessel movement and usage, impervious surfaces and stormwater facilities in uplands, stormwater flows and discharges). However, under Section 7 of the ESA, an assessment of all effects to listed species and critical habitat caused by the proposed action including those occurring outside of, or extending beyond, the Corps' jurisdictional boundaries must occur. The Corps includes, as a condition of the Corps permit, implementation of ESA requirements, including compliance with any incidental take statements set forth in biological opinions. In addition, if an activity not within the Corps' regulatory authority but results in a "take" of listed species as defined by the ESA and its implementing regulations, the permittee may be subject to penalties, enforcement actions, and other actions under Section 11 of the ESA.

The proposed action for SSNP includes but is not limited to: (1) construction of new in-water and overwater structures, (2) the expansion of existing in-water and overwater structures, and (3) the repair and replacement of in-water and overwater structures. When structures would be repaired[5] or replaced under SSNP, the proposed activity generally results in an extension of the

[5] Repair includes non-minor maintenance not falling under Project Design Criteria Number 7.

time the existing structures will exist on the landscape. At the same time, the currently existing, to-be-repaired, rebuilt and/or replaced structures are part of the environmental baseline conditions.

The proposed action for SSNP does not cover projects that result in a long-term loss of nearshore habitat function to ESA listed species and their designated critical habitat. One way project applicants can ensure their proposed project does not result in a long-term loss of habitat function is by calculating conservation offsets using NMFS' Puget Sound Nearshore Habitat Conservation Calculator (Calculator or Conservation Calculator) for certain activity types. More information on how this Calculator quantifies effects and potential offsets can be found in Appendix A.

As a programmatic consultation, SSNP is a voluntary option available to applicants with the intent to provide regulatory certainty and expedited ESA and EFH consultation. SSNP is applicable in the Salish Sea, extending into estuaries up to the highest point of saltwater influence. Applicants seeking Corps authorization can follow the SSNP design criteria, allowing them to take advantage of this consultation process, and the regulatory certainty and efficiencies provided by using SSNP. If applicants do not want to or are not able to follow the SSNP criteria, their proposed actions will be evaluated as an individual ESA consultation and will undergo a project-specific analysis.

Table 4. Summary of Covered Activities. Additional details and requirements found in Section D, below.

<table>
<tr><th>Activity Category</th><th>Associated Project Design Criteria (PDC) Number</th><th colspan="2">Activities Covered</th></tr>
<tr><td>Culvert and bridge repair and replacement resulting in improvements for fish passage</td><td>PDC #1</td><td colspan="2">Culvert and bridge repair, rehabilitation and replacement resulting in improved fish passage</td></tr>
<tr><td rowspan="5">Utilities (does not include construction or enlargement of any utility to support a new or expanded utility service area.)</td><td rowspan="5">PDC #2</td><td colspan="2">Relocating existing pipes or pipelines used to transport gas or liquids</td></tr>
<tr><td colspan="2">Relocating existing cables, lines, or wires used to transmit electricity or communications</td></tr>
<tr><td colspan="2">Repair, restoration, or replacement of existing pipes, pipelines, cables, lines, wires, and water intakes</td></tr>
<tr><td colspan="2">Underground utility line actions involving excavation, temporary side casting of excavated material, trenching, backfilling of the trench, and restoration of the work site to preconstruction contours and vegetation</td></tr>
<tr><td colspan="2">Overhead utility line actions involving long-term vegetation removal, excavation, grading, and installation of footings, foundations, or other structures in riparian and floodplain habitats</td></tr>
<tr><td>Stormwater facilities and outfalls</td><td>PDC #3</td><td colspan="2">The construction, repair, and replacement of stormwater facilities and outfalls, including the repair and replacement of outfalls</td></tr>
<tr><td rowspan="2">Shoreline modifications</td><td rowspan="2">PDC #4</td><td colspan="2">Repair, replacement, and/or installation of new rock, concrete, untreated wood, and steel sheet pile bulkheads</td></tr>
<tr><td colspan="2">Installation of soft and hybrid shoreline activities</td></tr>
<tr><td rowspan="6">Expand or install a new in-water or overwater structure</td><td rowspan="6">PDC #5</td><td colspan="2">All actions necessary to complete installation of the following:</td></tr>
<tr><td>Mooring buoys</td><td>Mooring dolphin/piles</td></tr>
<tr><td>Debris booms</td><td>Fender pile(s)</td></tr>
<tr><td>Staircases</td><td>Marine rails</td></tr>
<tr><td>Noncovered boat lift(s)</td><td>Boat ramps</td></tr>
<tr><td>Residential and community overwater structures</td><td></td></tr>
</table>

Activity Category	Associated Project Design Criteria (PDC) Number	Activities Covered	
Repair or replace an existing structure	PDC #6	Aids to navigation	House Boats
		Boat houses, covered boat houses, boat garages	Boat Ramps
		Breakwaters	Buoys and mooring structures
		Commercial, industrial, and residential piers	Wharfs, port, industrial, and marina facilities
		Pier, ramp and floats	Dolphins
		Float plane hangars	Float storage units
		Floating walkways	Debris booms
		Groins and jetties	
Minor maintenance of an existing structure	PDC #7	Pile resets	Capping of piles
		Replacement of rubber strips	Replacement of float stops
		Encapsulation of flotation material	Height extension of existing pilings
		Replacement of fender piles that do not contribute to the structural integrity of the structure	Replacing well-functioning solid decking with grated decking
Repair, replace, expand or install a new aid to navigation, scientific measurement device, or tideland marker.	PDC #8	All actions necessary to complete installation (e.g,. geotechnical surveys, pile driving, and excavation, grading, or filling) of the following:	
		Tideland markers	Aids to navigation
		Scientific measurement devices	
Dredging for vessel access	PDC #9	Dredging to maintain vessel access to previously authorized dredge prisms	
		Vessel access to previously authorized pier, ramp, floats, wharfs, mooring structures, marinas, marine terminals, or boat ramps	
Dredging and debris removal to maintain functionality of culverts, water intakes, or outfalls	PDC #10	Restore lost or impaired function of culvert, water intake, or outfall (Can include the addition of a fish screen for any water intake or point of diversion)	
Habitat enhancement activities	PDC #11	Wetland, shoreline, stream and floodplain restoration	

Activity Category	Associated Project Design Criteria (PDC) Number	Activities Covered
		In-water or over-water structure, rubble, or derelict vessel removal
Set-back or removal of existing bulkheads, tidegates, berms, dikes, or levees	PDC #12	Landward replacement or removal of tidegates, berms, dikes, bulkheads, or levees
Beach nourishment	PDC #13	Placement of beach nourishment in the nearshore habitat
Sediment/Soil remediation	PDC #14	Dredging, excavation, capping or other methods of removing or isolating contaminated sediments from aquatic habitats

The activities covered by SSNP will incorporate impact reduction measures including GCMs and PDCs as described in the subsections below to greatly reduce impacts of these activities to nearshore habitat function of the Salish Sea for ESA listed species and their designated critical habitat. In addition, for certain activity categories, conservation offsets will reduce long term impacts to ESA listed species and their designated critical habitat not addressed by GCMs or PDCs. GCMs and PDCs are required components of each project in order to be eligible to utilize this programmatic consultation. These requirements are needed to provide certainty of the analysis of the combined effects of the action and the consequences. Detailed information on project specific PDCs and GCMs can be found in the subsections below.

B. Program Administration

1. Initial Rollout

NMFS, USFWS, and the Corps will partner to provide an initial rollout of SSNP. The initial rollout will include joint public workshops to describe SSNP and NMFS guidance for use of the Calculator.

2. Timeline and Revisions

The Agencies will discuss any revisions or need for re-initiation during their Annual Coordination Meeting described in Section B.10.E.

3. Corps Review

During the Corps' review of the activity proposed by a Regulatory applicant, the Corps will determine whether the proposed work meets the following criteria and is therefore appropriate for coverage under the programmatic opinion:

a. The proposed work falls within the description of an activity in the proposed action and meets all applicable PDCs and GCMs.
b. Work is not split into smaller interdependent parts to facilitate or sequence consultation. As an example, interdependent work involving a culvert replacement, repair of a bulkhead, and replacement of a stormwater outfall cannot be separated into three separate consultation requests, each to be covered by individual or other programmatic consultations. All proposed work must be evaluated under this programmatic consultation (e.g., work cannot be partitioned and submitted under multiple programmatic consultations).
c. The proposed work conforms to all applicable Terms and Conditions (T&Cs) in the Incidental Take Statements (ITS) of the SSNP programmatic consultations with NMFS and USFWS.
d. The proposed work includes an individual response to the applicable EFH Conservation Recommendations accepted by the Corps.
e. The proposed work does not include or cause actions (that would not occur but for the proposed action and are reasonably certain to occur) that are specifically excluded from the proposed action.
f. The proposed work includes sufficient conservation offsets and required documentation as described in Program Administration # 8 Conservation Offsets, where applicable, to

address impacts to the Salish Sea nearshore environment on ESA listed species and designated critical habitat.

4. Electronic Submission

After the Corps conducts an initial review of the proposed project, and for projects it deems subject to consultation under the SSNP, the Corps will send a project notification to NMFS as detailed below:

a. NMFS Submission:
   1. Submit information to ssnp-wa@noaa.gov
   2. Email Subject Line: SSNP Verification (PDC #) OR SNNP Verification and Minor Alteration Request (PDC #, OR GCM #), OR SSNP Notification Only (PDC #).
   3. Within 5 days of receipt, NMFS will provide the Corps an email stating the request has been received. If the Corps has not received this email within 5 days, the Corps will seek to confirm whether NMFS has received the submitted materials.
   4. NMFS will endeavor to provide a response regarding verification to the Corps within 30 days from the date of the email submittal. The Corps must receive an affirmative decision from NMFS before verification is complete unless the project fully falls under PDC # 2 or PDC #8 as detailed in Section 1.3.B.5 below.

b. The email submission will include, at a minimum, the following information:
   1. Project Name and Corps Reference Number
   2. Brief project description
   3. Applicable PDC #(s)
   4. Project Drawings
   5. Information to show project meets SSNP requirements
   6. Conservation Offsets, if required (and Conservation Calculator, if utilized)

5. NMFS Review and Verification

NMFS verification is required for the following activity categories:

a. Projects that require a marine mammal monitoring plan
b. Culvert and bridge repair, and replacement resulting in improvements to fish passage (PDC #1)
c. Utility projects (PDC #2), including horizontal directional drilling (HDD)
d. Stormwater facilities and outfalls (PDC #3)
e. Shoreline modification (PDC #4)
f. Expand or install a new in-water or overwater structure (PDC #5)
g. Repair or replace an existing structure (PDC #6)
h. Minor maintenance of an existing structure (PDC #7)
i. Dredging for vessel access (PDC #9)
j. Dredging and debris removal to maintain functionality of culverts, water intakes, or outfalls (PDC #10)
k. Habitat enhancement activities (PDC #11)
l. Set-back or removal of existing tidegates, berms, dikes, or levees (PDC# 12)
m. Beach nourishment (PDC #13)
n. Contaminated sediments remediation (PDC #14)

NMFS verification is not required for the following activities under SSNP. If any of these "notification only" categories are part of a larger action that does require notification, they need to be included as part of the larger project:

a. Utilities (if no HDD) (PDC #2)
b. Repair, replace, expand or install a new aid to navigation, scientific measurement device, or tideland marker. (PDC #8)

For activities requiring NMFS verification, the Corps will submit to NMFS project information and conservation offsets (if required) to show SSNP requirements are met. NMFS will inform the Corps via email whether it agrees that the project meets the requirements of SSNP. If NMFS determines that the project meets SSNP's requirements, the email will identify that the project can be covered under the programmatic in the opinion of NMFS, and the Corps can proceed with a permit decision. If the project does not meet the requirements in NMFS' opinion, the email will identify which aspects of the project do not meet the SSNP conditions. The Corps and the applicants may evaluate the project and resubmit it with additional explanation if they disagree; however, NMFS will make the final determination as to whether a project meets SSNP's requirements.

Applicants of non-conforming projects may choose to either modify their project to meet SSNP requirements or submit a Biological Assessment and request individual ESA consultation.

6. Minor alterations from proposed measures

NMFS may approve the following minor alterations from the established GCMs or PDCs on a rare, case-by-case basis. The project notification requesting an alteration must include information detailing why the alteration is needed and how the proposal would not result in any adverse effects beyond those considered in the programmatic consultations. The NMFS will verify whether or not the resulting environmental and biological effects of the alteration fit within the provisions of the programmatic consultations and the opinions' analyses. The following minor alterations may be considered:

a. Work outside the specified in-water work period when the change would not result in any adverse effects beyond those considered in the programmatic consultations.
b. Alternate location for equipment, refueling, and staging due to topographical or other site-specific constraints.
c. Not installing an anti-perch device (on piling).
d. Marina facility expansion with no more than 1,000 square feet of additional over water coverage or 10 new slips, whichever is less, so long as the other criteria in PDC #5 are met.

7. Options for Projects that Do Not Comply with SSNP

If the Corps determines that a project is not covered by the programmatic consultations, or is informed by NMFS via the verification/notification process that the project is not consistent with the programmatic consultations, the Corps can:

a. Inform the permittee they can consider whether it is possible or desirable to modify their project to become consistent with the provisions of the SSNP proposed action; or
b. Inform the permittee of the option to withdraw their proposed project from consideration under the SSNP programmatic consultations and the Corps will proceed to work with them to request an individual ESA consultation.

8. Conservation Offsets

A number of activities included in the proposed action can result in the loss of nearshore habitat functions and values to ESA listed species and their designated critical habitat. To provide programmatic coverage for the effects of these activities under the ESA, it is necessary to ensure that the loss of habitat functions and values, resulting from individual projects, does not meaningfully aggregate over space and time.[6] To achieve this, project modification or conservation offsets are required for proposed activities resulting in loss of nearshore habitat functions and values for ESA-listed species and critical habitat. Compensatory mitigation required under Section 404 of the CWA can serve as conservation-offsetting measures if such compensatory mitigation is consistent with the criteria set forth in the programmatic consultations under the ESA. One way, project applicants can ensure their proposed project does not result in a long-term loss of habitat function by calculating conservation offsets utilizing NMFS' Puget Sound Nearshore Calculator (Calculator) for certain activity types (Appendix 1).[7]

a. Conservation offsets are needed for the following activity categories:
   i. PDC #2 Utilities. New footings for relocated transmission lines
   ii. PDC #4 Shoreline modification
   iii. PDC #5 Expand or install a new in-water or overwater structure
   iv. PDC #6 Repair or replace an existing structure
   v. PDC #9 Dredging for vessel access
b. Enduring adverse effects on nearshore habitat, from the activities identified above, must be offset with an equal (or greater) amount of conservation offsets (compared to project effects/debits). The following actions may be used solely or in any combination with each other to achieve the necessary conservation offsets
   i. **Option 1**. Design project to avoid and minimize adverse effects under the ESA by incorporating and documenting, with a permittee's project submission, some or all of the following techniques:
      (a) Setback bulkheads/shoreline armoring landward/above Highest Astronomical Tide (HAT)
      (b) Use "Soft-shore" or hybrid bank armoring design instead of hard armor. For definitions of soft-shore and hybrid (*see* PDC#4).

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[6] It would be difficult to determine if the proposed action would not jeopardize the continued existence of listed species or adversely modify critical habitat if projects resulted in an uncertain amount of long-term loss of habitat function and value.

[7] Any alternative analytical tools to NMFS's Calculator must be: (1) based on the best available science; (2) based on an assessment of nearshore physical and biological features supporting the conservation of ESA listed species affected by the proposed project; and (3) be able to demonstrate equivalency between habitat impacts of the proposed project and conservation offsets offered to compensate for those habitat impacts. NMFS will evaluate any proposed alternative and determine if it meets these criteria, thereby ensuring no net loss of long-term habitat function.

(c) Replace some hard bank armoring with a pocket beach.
(d) Reduce overwater footprint (e.g., less overwater structure (sq ft), fewer piles).
(e) Reduce footprint of nearshore structures, including jetties and boat ramps.
(f) Increase grating in decking which reduces debits but may not eliminate effects in cases where it extends the life of the structure.
(g) Increase creosote removal.

ii. **Option 2.** Implement applicant-responsible within-basin habitat improvements (including on-site habitat improvements). Within-basin applicant-responsible habitat improvements are those that would occur within the boundaries of the applicant's property (on-site) or at a different location within-basin property (off-site) where the permittee has ownership or secured permission and a conservation easement, if necessary. Applicant-responsible within-basin habitat improvements needs to be implemented with the full discretion and control of the applicant. Habitat improvements that may result in conservation offsets include, but are not limited to:
(a) Removal of existing over-water structures or piles;
(b) Removal of distinct portions of over-water structures that can be removed without affecting the structural integrity of the remaining structure (for example one float of a multi float complex);
(c) Removal of derelict structures or rubble;
(d) Removal of hard shoreline armoring including replacement of hard armoring with soft and hybrid approaches;
(e) Partial removal of shoreline armoring where a pocket beach is incorporated;
(f) Removal of creosote;
(g) Planting or relocating of submerged aquatic vegetation (SAV);
(h) Shoreline planting of native (non-submerged) vegetation[8]; and
(i) Beach nourishment or other kinds of enhancement of forage fish habitat.

iii. For applicants choosing Option 2 to meet required conservation offsets in whole or in part, the following is required:
(a) A Habitat Improvement Plan. The plan must include a description of the type(s) of habitat improvements, including:
(1) A quantitative description of habitat improvements (e.g., square foot of overwater structure removed, linear foot shoreline armoring removed, toe elevations of shoreline armor setback, cubic yards of gravel placement);
(2) Where the improvements would occur;
(3) How the improvements would occur (e.g., any construction type actions); and
(4) When the improvements would occur.
(b) Description of the site protection mechanism where applicable. For example, a conservation easement is needed with shoreline plantings but not necessary for rubble removal. A conservation easement associated with the removal of shoreline armoring may increase offsets.
(c) For planting related activities, submit a planting and monitoring plan with your consultation initiation package.

[8] May require a conservation easement.

(d) A written agreement with offsite landowner(s) (if improvements are not occurring on applicant-owned or controlled land) that documents the landowner(s)'s consent to the Habitat Improvement Plan.

(e) Applicant-responsible habitat improvement projects under Option 2 must be completed within three years of the impacting project's construction start date.

iv. **Option 3.** Provide funding to a local habitat restoration "sponsor" (i.e., a state agency, Regional Organization, designated Lead Entity, Conservation District or Regional Fisheries Enhancement Group) to support a within-basin restoration project that will improve nearshore or estuarine habitat.

v. For applicants choosing Option 3 to meet required conservation offsets in whole or in part, the following is required:

(f) A Habitat Improvement Plan. The plan must include a description of the type(s) of habitat improvements, including:

(1) Quantitative description of habitat improvements (e.g., sq ft of overwater structure removed, lf shoreline armoring removed, cubic yards of gravel placement);

(2) Where the improvements would occur;

(3) How the improvements would occur (e.g., any construction type actions); and

(4) When the improvements would occur

(g) Documentation of a funding (or equivalent) arrangement or agreement between the restoration project sponsor and the applicant;

(h) Written assurances from the restoration project sponsor that the identified restoration project will occur within three years of funding being received.

(i) Documentation that funds have been paid to the habitat restoration partner prior to construction of the impacting project's construction start date.

vi. **Option 4.** Purchase conservation credits from a NMFS-approved conservation bank, in-lieu fee program, and/or crediting provider to support a within-basin restoration project that will improve nearshore or estuarine habitat

vii. For applicants choosing Option 4 to meet required conservation offsets in whole or in part, the following is required:

(a) Documentation of a presale (or equivalent) agreement between credit provider and permittee that identifies the number of credits/offsets the permittee intends to purchase included within the material submitted for programmatic verification.

(b) Documentation that all required credits/offsets were purchased provided to the Corps and NMFS prior to the impacting project's construction start date.

9. Marine Mammals

In-water construction activities causing underwater noise greater than 120 dB_{rms}, such as pile driving, jackhammering, and underwater sawing, will shut down if marine mammals enter the zone of influence.[9] Construction activities will not resume until all marine mammals have been cleared from the zone of influence and are observed to be moving away from the project site.

[9] During vibratory pile driving, the zone of influence extends to the 120dB_{rms} isopleth and extends to the 160dB_{rms} isopleth during impact pile driving.

a. If Southern Resident Killer whales (SRKW) have been documented more than four times during the proposed work window in the quadrant the project area is in, a Marine Mammal Monitoring Plan (MMMP) must be prepared and submitted with the project notification. The MMMP will be reviewed by a NMFS biologist. The goal of a MMMP is to stop or not start work if a marine mammal is in the area where it may be affected by pile driving noise.
b. If in the previous two years there were four or more humpback whale sightings during the proposed work month, in the action area of the proposed work, a MMMP must be submitted with the project notification.
c. NOAA's website identifies these quadrants and contains guidance on the potential for ESA-listed marine mammal occurrences in project areas: http://www.westcoast.fisheries.noaa.gov/protected_species/marine_mammals/evaluating_sound.html
d. Check the Orca Network Sightings Maps at: http://www.orcanetwork.org/Archives/index.php?categories_file=Sightings%20Archives%20Home for Humpback whale sightings.
e. Guidance for developing an MMMP can be found on NOAA's website: http://www.westcoast.fisheries.noaa.gov/protected_species/marine_mammals/monitoring_plan_guidance.html

10. Monitoring and Reporting

The permittee must provide the following information to the Corps and NMFS for each project to be completed under this programmatic consultation. All project notifications and reports are to be submitted electronically to the Corps at nws.compliance@usace.army.mil, NMFS SSNP mailbox at ssnp-wa.wcr@noaa.gov, and USFWS at WashingtonFWO@fws.gov, including:

a. Certificate of Compliance with Department of Army Permit per the terms of the Corps Permit.
b. If the work area is isolated, a fish salvage report within 60 days of work area isolation with fish capture even if no fish were captured.
c. Dredging reports:
   i. For multiple year vessel access and functionality maintenance dredging actions, the permittee will provide pre- and post-dredging reports for each year of activity for each project. This information will need to be submitted in addition to the project notification and Certificate of Compliance with Department of Army Permit. Annual pre-dredging reports will be submitted a minimum of 30 days prior to each dredging event. Annual post-dredging reports will be submitted concurrent with notification requirements issued by state or federal dredging authority.
   ii. Annual Post-dredging Reports will include:
      (1) Method of dredging and equipment used in dredging operation
      (2) Amount of material removed during dredging
      (3) Actual footprint of dredging
      (4) Dates on which dredging occurred and time at which dredging occurred
      (5) Location of disposal of dredged materials
d. Conservation Offset Documentation:

e. Applicants acquiring offsets under Program Administration #8, conservation offsets option 2, must submit written confirmation to the Corps and NMFS, that they implemented their verified habitat improvement plan (e.g., planted vegetation consistent with the planting plan, removed proposed piles, etc.) within 60 days from completing those conservation offsets. Per Option 2, all offsets must be completed within three years from impacting project's construction start date, thus this confirmation must be submitted within three years and 60 days from the impacting project's construction start date at the latest.
f. Annual Program Report. The Corps will submit an Annual Report to the NMFS at ssnp-wa.wcr@noaa.gov and USFWS at WashingtonFWO@fws.gov by March 15 each year. NMFS, USFWS, and the Corps will develop the parameters of the report within 6 months of signature of the Biological Opinions for these programmatic consultations.
g. Annual Coordination Meeting. The Agencies will meet annually by May 15 each year to discuss the Annual Report and any actions that can improve conservation, efficiency, or comprehensiveness under these programmatic consultations.

C. General Construction Measures

Projects covered under SSNP must comply with the following General Construction Measures (GCMs) as applicable.

1. Minimize Construction Impacts at Project Site

a. To the extent feasible, retain natural vegetation, limit impermeable surfaces, limit duration of in-water work and otherwise minimize the extent and duration of earthwork (e.g., compacting, dredging, drilling, excavation, and filling).

2. In-Water Work Timing

a. Complete all work waterward of the line of the Highest Astronomical Tide (HAT) during dates listed in the most recent version of in-water work guidelines, Washington Department of Fish and Wildlife (WDFW) Marine Water Work Windows: https://app.leg.wa.gov/WAC/default.aspx?cite=220-660-330
b. Hydraulic and bathymetric measurement, sediment sampling and geotechnical sampling are not constrained by the work timing constraints in (a) above and may be completed at any time.

3. Isolation of Concrete Work

All concrete will be placed in the dry (e.g., isolated from water) or within confined waters (i.e., within a form or cofferdam) not connected to surface waters and will be allowed to cure a minimum of 7 days before contact with surface water. Should new concrete technology develop which has a quicker curing rate, information must be provided as part of the project submittal and NMFS will evaluate whether a shorter cure time will be no more impactful than the cure time evaluated in this Opinion.

4. Fish Screens

Whenever diverting or pumping surface water or water in an isolated work area, a fish screen that meets the most recent revisions of NMFS' fish screen criteria will be installed prior to and during pumping activities and will be maintained in a condition that prevents fish movement through the barrier. Fish screen criteria can be found in Chapter 11 of NMFS Anadromous Salmonid Fish Facility manual or most recent version (NMFS 2022): https://media.fisheries.noaa.gov/2022-06/anadromous-salmonid-passage-design-manual-2022.pdf. If at any time fish screens have damage, pumping activities and in-water work shall cease until damaged fish screens are repaired.

5. Drilling, Boring, and Tunneling

a. If drilling, boring, or tunneling are used, isolate drilling operations in wetted areas using a steel casing or other appropriate isolation method to prevent drilling fluids from contacting water.
b. If drilling through decking is necessary, use containment measures to prevent drilling debris from entering the water.
c. Sampling and directional drill recovery/recycling pits, and any associated waste or spoils will be completely isolated from surface waters and wetlands.
d. All waste or spoils will be covered if precipitation is falling or imminent.
e. All drilling fluids and waste will be recovered and recycled or disposed of to prevent entry into the water.
f. If a drill boring case breaks and drilling fluid or waste is visible in water or a wetland, make all possible efforts to contain the waste.
g. All drilling equipment, drill recovery and recycling pits, and any waste or spoil produced, will be contained and then completely recovered and recycled or disposed of as necessary to prevent entry into any waterway. Use a tank to recycle drilling fluids.
h. When drilling is completed, remove as much of the remaining drilling fluid as possible from the casing (e.g., by pumping) to reduce turbidity when the casing is removed.
i. Drilling, boring, or coring may be used to collect sediment samples/cores. Work at contaminated sites is addressed in PDC #14.

6. Pile Installation

Piles may be round concrete, steel pipe, untreated wood or some pressure-treated wood with appropriate wrapping (see below). Pressure-treated wood may be installed as described below. Piles must be 36 inches in diameter or smaller or steel H-pile designated as HP 24 inches or smaller.

a. Whenever practical, use a vibratory hammer for in-water pile installation.
b. Jetting may be used to install pile in areas with coarse, uncontaminated sediments that meet criteria for unconfined in-water disposal.
c. When using an impact hammer to drive or proof a steel pile, one of the following sound attenuation methods will be used: (a) complete isolation from water by dewatering the area around the pile; (b) a double-walled pile; or (c) a bubble curtain that will distribute small air bubbles around the pile perimeter for the full depth of the water column during pile installation (*see* NMFS and USFWS (2006), CALTRANS Technical Report No.

CTHWASSNP-RT-306.01.01 (2015), Wursig et al. (2000), and Longmuir and Lively (2001)); or c) if water velocity is greater than 1.6 feet per second, the permittee will use a confined bubble curtain (e.g., surrounded by a fabric or sleeve) that will distribute air bubbles around 100% of the pile perimeter for the full depth of the water column during impact pile installation. New technologies that have demonstrated equivalent sound attenuation can be used if verified by NMFS.

d. To assist a permittee in determining biological monitoring needs during pile installation, an optional Pile Installation Calculator[10] is available. The tool aids in determining the extent of underwater noise impacts and distances.

7. Marbled Murrelet Monitoring Plan [does not address NMFS trust resources]

The permittee will develop and implement a marbled murrelet monitoring plan for projects that include in-water impact pile driving when injurious sound pressure levels are expected or when in-air sounds are expected to cause masking effects.

a. Permittees may request technical assistance from the USFWS while developing a Marbled Murrelet Monitoring Plan to ensure it meets requirements under the USFWS Protocol for Marbled Murrelet Monitoring During Pile Driving (further detail will be provided in USFWS's Biological Opinion for this programmatic consultation). A plan must be submitted with the project notification.
b. Observers will visually monitor the monitoring area (area of potential injury or masking) for marbled murrelets following the protocol provided in USFWS's Biological Opinion for SSNP.
c. An appropriate number of qualified marbled murrelet observers will be positioned to provide adequate coverage of the monitoring area without looking farther than 50 meters to ensure no murrelets are in the monitoring area.
d. All monitoring will be conducted by observers meeting appropriate qualifications and certified by the USFWS.
e. One qualified biologist will be identified as the Lead Biologist. The Lead Biologist has the authority to stop pile driving when murrelets are detected in the monitoring area or when visibility impairs monitoring.
f. If murrelets are spotted in the monitoring area, pile driving will not resume until the murrelets have left the monitoring area and at least 2 full sweeps of the monitoring area have confirmed no murrelets are present. If visibility impairs monitoring, pile driving will not resume until effective monitoring can be conducted.
g. If weather or sea conditions restrict the observer's ability to observe for marbled murrelets, or become unsafe for the monitoring vessels to operate, cease pile installation until conditions allow for monitoring to resume. Monitoring will only occur when the sea state is at a Beaufort scale of 2 or less.

8. Treated Wood Piles

Inorganic arsenical pressure-treated wood piles (chromated copper arsenate (CCA) or ammoniacal copper zinc arsenate (ACZA)) that are sealed with a wrapping or a polyurea barrier

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[10]**Calculator:** https://www.fisheries.noaa.gov/southeast/consultations/section-7-consultation-guidance
User Guide: https://media.fisheries.noaa.gov/2022-01/Instructions%20%28captions%29%20AUDIO_508.pdf

may be installed under SSNP. Any proposal to use arsenical pressure-treated wood pilings without a wrapping or polyurea barrier systems is not covered by SSNP. Pile wrappings must meet the following criteria:

a. Wrappings are made from a pre-formed plastic such as polyvinyl chloride (PVC), a fiber glass-reinforced plastic or a high density polyethylene (HDPE) with an epoxy fill or petrolatum saturated tape (PST) inner wrap in the void between the HDPE and the pile.
b. Wrapping material used for interior pilings must be a minimum of 1/10 of an inch thick, durable enough to maintain integrity for at least 10 years, and have all joints sealed to prevent leakage.
c. Wrapping material used for exterior pilings that come into direct contact with ocean going vessels or barges must be HDPE pile wrappings with epoxy fill or PST inner wrap.
d. The tops of all wrapped piles must be capped or sealed to prevent exposure of the treated wood surface to the water column and to prevent preservative from dripping into the water.
e. Polyurea barrier systems must meet these additional criteria:
    i. The polyurea barrier must be an impact-resistant, biologically inert coating that lasts or can be maintained for 10 years and in accordance with American Wood Protection Association M 27 standard.
    ii. The polyurea barrier must be ultraviolet light resistant and a minimum of 250 mm (0.25 inch) thick in the area that is submerged (Morrell 2017).
    iii. Polyurea barriers must be installed on dry piles that are free of loose wood, splinters, sawdust or mechanical damage.
    iv. Wrappings or polyurea barriers will extend both above and below the portion of the pile that is in contact with the water. The wrapping or polyurea barrier must extend at least 18 inches below the mudline into the substrate and to the top of the pile.
    v. All operations to prepare wrappings or polyurea barriers for installation over piles (cutting, drilling, and placement of epoxy fill) will occur in a staging area away from the waterbody.
    vi. All piles with wrappings or polyurea barriers must be regularly inspected and maintained to identify unobserved failures of the wrapping or polyurea barrier or anytime a wrapping or polyurea barrier breach is observed.

9. Pile Removal - Intact

The following steps will be used to minimize contaminant release, sediment disturbance, and total suspended solids when removing an intact pile:

a. Install a floating surface boom to capture floating surface debris.
b. To the extent possible, keep all equipment (e.g., bucket, steel cable, vibratory hammer) out of the water, grip piles above the waterline, and complete all work during low water and low current conditions.
c. Dislodge (i.e., wake up) the piling with a vibratory hammer, whenever feasible.
d. Slowly lift piles from the sediment and through the water column.
e. Place piles in a containment basin on a barge deck, pier, or shoreline without attempting to clean or remove any adhering sediment. A containment basin for the removed piles and any adhering sediment may be constructed of durable plastic sheeting with continuous sidewalls supported by hay bales or other support to contain all sediment and

return flow which may otherwise be directed back to the waterway. Containment basin shall be lined with an oil absorbent boom.

f. Dispose of all removed piles, floating surface debris, any sediment spilled on work surfaces, and all containment supplies at a permitted upland disposal site.

10. Pile Removal - Broken or Intractable Pile

a. If a pile breaks above the surface of uncontaminated sediment, or less than two feet below the surface, make every feasible attempt short of excavation to remove it entirely. If the pile cannot be removed without excavation, drive the pile deeper if possible.
b. If a pile in contaminated sediment is intractable or breaks above the surface, of contaminated sediment, cut the pile or stump off at the sediment line. Cutting the pile up to two feet below the sediment line is allowed if required by a state permit or other authorization.
c. If a pile breaks below the surface of contaminated sediment, make no further effort to remove it.

11. Treated Wood For Uses Other Than Piles

The following criteria pertains to the repair or maintenance of pre-existing bridges, boardwalks, pier, ramp and floats, footbridges, piers, stringers, and structures in or near waterways and wetlands:

a. Pesticide and preservative-treated wood can only be used for substructures that are not in direct exposure to leaching by precipitation, overtopping waves, or submersion. Treated wood is prohibited for the application of decking and repair or replacement of bulkheads.
b. Treated wood shipped to the project area will be stored out of contact with standing water and wet soil and will be protected from precipitation.
c. Each load and piece of treated wood will be visually inspected and rejected for use in or above aquatic environments if visible residue, bleeding of preservative, preservative-saturated sawdust, contaminated soil, or other dispersible materials are present.
d. Offsite prefabrication will be used whenever possible to minimize cutting, drilling and field preservative treatment over or near water.
e. When upland on-site fabrication is necessary, all drilling, and field preservative treatment of exposed treated wood will be done above the plane of the High Tide Line to minimize discharge of sawdust, drill shavings, excess preservative and other debris. Tarps, plastic tubs, or similar devices will be used to contain the bulk of any fabrication debris, and any excess field preservative will be removed from the treated wood by wiping and proper disposal to prevent run-off to marine waters. Upland, on-site, cutting of treated wood shall occur 50 feet from open water.
f. Cutting of treated wood in nearshore areas shall include means of minimizing sawdust contamination, such as vacuum dust collectors or similar means of collecting dust.
g. Evaluate all wood construction debris removed during a project to ensure proper disposal of treated wood.
h. Ensure that no treated wood debris falls into the water or, if debris does fall into the water, remove it immediately.
i. After removal, place treated wood debris in an appropriate dry storage site protected from precipitation until it can be removed from the project area.

j. Treated wood debris shall not be left in the water or stacked at or below the High Tide Line.

12. Barge Use

a. Barges will be large enough to remain stable under foreseeable loads and adverse conditions.
b. Barges will be inspected before arrival to ensure the vessel and ballast are free of invasive species if the barge has been used in any other water body.
c. Barges will be secured, stabilized, and maintained as necessary to ensure no loss of balance, stability, anchorage, or other condition that can result in the release of contaminants or construction debris.
d. Ensure the barge does not ground out.

13. Stormwater Management

Stormwater management, as described below, is required for PDC #3 and any other project that will create or prolong stormwater runoff discharging to a stream, river, estuary, or nearshore marine area when that proposed project: (1) Includes construction of new impervious surface that; (2) repairs or replaces existing impervious surface when the stormwater management at the site does not currently meet all the criteria identified below; or (3) prolongs the life of an existing impervious surface and the stormwater management at the site does not currently meet the all of the criteria identified below. As an example for #3, above, if a marine bulkhead supporting a parking lot is proposed for replacement, and the parking lot could not exist but for the replacement of the bulkhead, stormwater management for the parking lot must meet the criteria below.

The proposed action for SSNP only includes construction of new contributing impervious surface or repair or replacement of impervious surface when that surface is associated with another activity included as part of the proposed action under SSNP. For instance, the construction of parking lots and access roads associated with a new boat ramp (PDC #5) are part of the proposed action for SSNP Programmatic Consultations (provided the activity meets this GCM). Similarly, if a fish passage improvement project (PDC #1 or PDC #11) in the form of a bridge results in new or replaced impervious surfaces, that new or replaced impervious surface would be required to comply with this GCM. The proposed action for SSNP does not include construction of new impervious surfaces for residential, commercial, or industrial development unrelated to another covered SSNP activity. Such new, unrelated construction is beyond the scope of the programmatic analysis for this consultation.

a. The following actions do not require any post-construction stormwater management:
   i. Removing marine debris or marine life from existing outfalls.
   ii. Replacing outfall flap gates or flow control devices.
   iii. Minor repairs or non-structural pavement preservation including installation or repair of guard rails, patching, chip seal, grind/inlay, overlay; removal or plugging of scuppers in a way that benefits stormwater treatment.

iv. Modifying on-street parking modifications that reduce contributing impervious surfaces.
v. Retrofitting, without increasing the amount of pollution generating impervious surface (PGIS), an existing impervious surface (pavement, parking lot, etc.) as necessary and required by law to comply with Americans with Disabilities Act (ADA) standards for accessible design (e.g., curbcuts). This does not include retrofitting of overwater structures.
vi. Minor building repairs such as re-roofing, re-siding, painting, replacing or installing fasteners, shingles, flashing, and gutters, or similar building elements. [11]

b. For residential application, hardscape areas should utilize pervious materials (e.g., pavers, porous concrete) as feasible; if infeasible, incorporate rain gardens, bioswales, planted wetponds or comparable Low Impact Development (LID) treatments. [12]
c. For commercial, industrial, or public application, utilize LID[13] approaches to design stormwater treatment and management facilities. LID uses on-site features to maximize evapotranspiration and infiltration, which improve water quality and reduce adverse effects to receiving waters such as hydromodification. Manufactured (or proprietary) stormwater facilities, or alternative approaches, will only be considered if site constraints preclude the implementation of LID methods or the alternative can demonstrate improvement in ecosystem health and function commensurate with identified LID practices. Examples of LID practices, ordered by preference, include:
   i. Minimize impervious area.
   ii. Limit disturbance.[14]
   iii. Landscape and hardscape areas.[15]
d. Provide a Post-Construction Stormwater Management Plan (PCSMP) for any action proposed to be carried out consistent this GCM. This plan will be validated by NMFS during the verification step described in Section B.5 (Program Administration – NMFS Review and Verification). A PCSMP must include the following information:

[11] If galvanized metals are used, these materials in roofing must be painted or sealed to reduce introduction of zinc in roof runoff.

[12] See e.g., Fassman and Blackbourn 2010, Drake et al., 2014; Alizadehtazi et al. 2016 re feasibility of pervious materials; see Himnam 2005, Hinmann and Washington Dep't of Ecology 2013, and Skaloud 2016 re LID stormwater management.

[13]Low Impact Development (LID) (https://ecology.wa.gov/DOE/files/0b/0b070df2-4aff-4e74-821a-152e3fcb4ff5.pdf), also referred to as green infrastructure, is a stormwater and land-use management strategy that tries to mimic natural hydrologic conditions by emphasizing the following techniques: conservation, use of on-site natural features, site planning, and distributed stormwater BMPs integrated into a project design

[14] Examples include: construction sequencing, conserving soils with best drainage, cluster development, tree protection

[15] Examples include: restored soils, tree planting, de-pave existing pavement (such that it becomes a pervious area), contained planters (over impervious areas), vegetated roof, porous pavement, infiltration rain garden, LID swale, stormwater planter, soakage trench (some forms of underground injection control [UIC] may count as LID), drywell (some forms of UIC may count as LID), water quality conveyance swale, vegetated filter strips, downspout disconnection, lined rain garden, LID swale, stormwater planter. Underground Injection Control (UIC) refers to any Class V underground injection control system. Any proposed UIC must be compliant with the Washington Department of Ecology rules for installation of an UIC. Additionally, local jurisdictions may have further restrictions on the use and installation of UICs for stormwater management. Any UIC proposed to receive stormwater from a wearing surface (e.g., road, parking area, driveway) must receive water quality treatment prior to discharge to the UIC.

i. All relevant plans, drawings, exhibits, and a narrative report addressing PDC #3 below, that describes, explains, and defines the proposed project. Any engineering design sheets must be stamped and signed by a professional engineer licensed to practice in the state of Washington.
ii. Site maps indicating the following elements within the project boundaries
   (c) Property boundaries and project boundaries, especially if the project includes activities extending beyond/outside the property or parcel boundaries.
   (d) Impervious areas, landscape areas, and undeveloped natural areas (e.g., forested areas, wetlands, riparian zones).
   (e) Location and extent of all LID stormwater facilities and BMPs by type and capacity.
   (f) Location and extent of proprietary stormwater treatment technologies[16] by type and capacity, if proposed.
   (g) Location and extent of other structural source control practices by type and capacity (e.g., special practices for known or suspected contaminated sites, methods for targeting specific pollutants of concern).
   (h) All runoff discharge points and conveyance paths to the nearest receiving water.

e. Water Quality Treatment Analysis that describes how LID or commensurate practices will treat the water quality design storm[17][18] and provide adequate treatment for runoff that will be discharged from the site,[19] based on design storm flows.[20] The Water Quality Treatment Analysis should include:

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[16] A proprietary stormwater treatment system is a water quality treatment system constructed from engineered materials. Common proprietary stormwater facilities include filter vaults, modular wetlands, and other emerging technologies. Use of proprietary stormwater facilities must be certified for use by the Washington Department of Ecology. Such systems must be certified for General Use Designation (GULD) or Conditional Use Designation (CULD) in certain circumstances. Proprietary treatment systems proposed to treat stormwater from wearing surfaces (roadways, bridges, parking lots, driveways) must also be certified to provide "enhanced treatment" for removal of dissolved metals. Ecology's list of approved technologies can be accessed at: https://ecology.wa.gov/Regulations-Permits/Guidance-technical-assistance/Stormwater-permittee-guidance-resources/Emerging-stormwater-treatment-technologies.

[17] The water quality design storm defines the magnitude of the precipitation event that must be managed for water quality. A continuous simulation model should be used to establish the design storm for a particular site. When designing a flow rate-based stormwater facility, a calibrated, approved continuous simulation hydrologic model based on the Hydrologic Simulation Program – Fortran (HSPF), or similar, should be employed. When designing a volume-based stormwater facility, a calibrated, approved continuous simulation hydrologic model, such as MGSFlood or the Washington Department of Ecology's *Western Washington Hydrologic Model* (WWHM), should be employed.

[18] If 100% treatment of the water quality design storm is achieved, runoff discharged from the facility in excess of the water quantity design storm is considered treated for the purposes of this proposed action.

[19] A BMP sizing tool may be used if the local jurisdiction has such calculator tools available. However, in addition to providing the output from the BMP sizing calculator, also provide data on the facilities' treatment and flow control effectiveness using approved modeling methods.

[20] The water quality design storm defines the magnitude of the precipitation event that must be managed for water quality. A continuous simulation model should be used to establish the design storm for a particular site. When designing a flow rate-based stormwater facility, a calibrated, approved continuous simulation hydrologic model based on the Hydrologic Simulation Program – Fortran (HSPF), or similar, should be employed. When designing a volume-based stormwater facility, a calibrated, approved continuous simulation hydrologic model, such as

i. Descriptions of each proposed LID facility's capacity in terms of discharge or volume depending on the type of facility (i.e., flow rate or volume managed facilities).
ii. If proposed, describe each proprietary stormwater treatment facility's capacity to treat the water quality design storm and provide adequate treatment for runoff that will be discharged from the site.
iii. Describe any other structural source control practices that address LID or proprietary facilities treatment efficiency objectives (i.e., amount or percent of contaminant reduction, treatment, or management).

f. Flow Control Analysis that describes how treatment facilities (LID or commensurate practices) will manage and control the quantity of stormwater discharged from the site (i.e., detention, retention). Flow control is required for all projects, unless the outfall of the stormwater facility discharges directly into a major water body or directly to nearshore marine areas. Post-construction stormwater flow control methods shall demonstrate that the post-construction stormwater runoff is equal to, or less than, the pre-development[21] stormwater runoff for all storm events between the 50% of the 2-year, 24-hour and the 10-year storm events.
i. Describe each proposed LID facility's capacity in terms of flow or volume retention/detention depending on facility type.
ii. Describe each proprietary stormwater facility's capacity in terms of flow or volume retention/detention depending on facility type.
iii. Describe any other structural source control practices in terms of flow or volume retention/detention depending on facility type.

g. If relevant, a description of how the proposed stormwater treatment prevents adverse hydromodification[22] of receiving waters. This step would not typically be required for discharge directly into nearshore marine areas. This step is necessary if a project will:
i. Peak runoff exceeds 0.5 cfs during the 2-year, 24-hour storm event; and,
ii. Not meet the flow control requirements, detailed above; and,
iii. Discharge into an intermittent or perennial water body with a watershed area less than 100 square miles above the discharge location.

h. Flow control treatment and practices must be designed using continuous simulation modeling to ensure facilities are designed to capture the frequency and duration of flows generated by storms within the following criteria:
i. Lower discharge endpoint, by U.S. Geological Survey (USGS) flood frequency zone = 50% of 2-year event (i.e., Water Quality Design Storm)
ii. Upper discharge endpoint
(i) Entrenchment ratio[23] <2.2 = 10-year event, 24-hour storm; or,

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MGSFlood or the Washington Department of Ecology's Western Washington Hydrologic Model (WWHM), should be employed.

[21] Pre-development site conditions assume the natural, undeveloped conditions of the project site. Runoff curve numbers should reflect the site's likely natural habitat that was historically present and at its highest quality rating.

[22] Adverse hydromodification from stormwater discharge encompasses harmful changes to a receiving water's physical characteristics because of the rate, volume, or concentration of stormwater discharge. Common adverse hydromodification examples include erosion, sedimentation, down-cutting, accretion, or other alterations of the bio-geophysical conditions of the receiving water.

[23] Entrenchment ratio is a measurement of the vertical containment of a stream or river. It is calculated as the floodprone width, divided by the surface bankfull discharge width. The lower the entrenchment ratio, the more

(j) Entrenchment ratio >2.2 = bank overtopping event.

i. Provide a description of the stormwater conveyance system. When conveyance is necessary to discharge treated stormwater directly into a surface water or a wetland, the following requirements apply:
   i. Maintain natural drainage patterns such that runoff is not redirected to a different drainage basin (i.e., watershed, subwatershed) from the pre-project conditions.
   ii. Ensure that treatment for post-construction runoff from the site is completed before it is allowed to commingle with any offsite runoff in the conveyance.
   iii. Prevent erosion of the flow path from the project to the receiving water(s). If preventing erosion using a natural flow path is not feasible, use manufactured elements (e.g., pipes, ditches, discharge facility protection) to discharge runoff that extends below the OHWM or HTL elevation of the receiving water.[24]

j. Provide an Operations and Maintenance Plan that describes the schedule of the proposed inspection as well as maintenance activities for the stormwater facilities. This plan will be validated by NMFS during the verification step described in Section B.5. The party that is legally responsible for maintenance and monitoring activities should also be stated. Finally, describe events that would trigger an inspection outside of routine inspection (e.g., a large storm event, localized flooding). Provide a contact phone number and email address for the legally responsible party or parties.

k. The name, email address, and telephone number of the person responsible for designing the stormwater management facilities, so that NMFS may contact that person if additional information is necessary.

14. Pollution and Erosion Control

a. Use site planning and site erosion control measures commensurate with the scope of the project to minimize damage to natural vegetation and permeable soils and prevent erosion and sediment discharge from the project site.

b. Before significant earthwork begins, install appropriate, temporary erosion controls downslope to prevent sediment deposition in the riparian area, wetlands, or water body. In tidal areas, plan work in dry areas as much as possible.

c. During construction:
   i. Complete earthwork in wetlands, riparian areas, and stream channels as quickly as possible.
   ii. Cease project operations when high flows may inundate the project area, except for efforts to avoid or minimize resource damage.
   iii. If eroded sediment appears likely to be deposited in the stream during construction, install additional sediment barriers as necessary.
   iv. Temporary erosion control measures may include fiber wattles, silt fences, jute matting, wood fiber mulch and soil binder, or geotextiles and geosynthetic fabric but should not include materials made of plastic.

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vertical containment of flood flows exists. Higher entrenchment ratios depict more floodplain development (U.S. EPA 2016a).

[24] Note: Activities occurring above the OHWM or HTL do not fall under the Corps' authority established by the CWA or RHA. Nevertheless, often the activities it permits result in other activities outside its jurisdiction and associated effects that would not occur but for the Corp's action and are reasonably certain to occur; such activities are included and evaluated within the SSNP Opinions as effects of the proposed action.

v. Soil stabilization using wood fiber mulch and tackifier (hydro-applied) may be used to reduce erosion of bare soil, if the materials are free of noxious weeds and non-toxic to aquatic and terrestrial animals, soil microorganisms, and vegetation.
vi. Inspect and monitor pollution and erosion control measures throughout the length of the project.
vii. Remove sediment from erosion controls if it reaches one-third of the exposed height of the control.
viii. Whenever surface water is present, maintain a supply of sediment control materials and an oil-absorbing floating boom at the project site.
ix. Stabilize all disturbed soils following any break in work unless construction will resume within four days.

d. Remove temporary erosion controls after construction is complete and the site is fully stabilized.

15. Fish Capture and Release

a. If practicable, allow listed fish species to migrate out of the work area or remove fish before dewatering; otherwise remove fish from an exclusion area as it is slowly dewatered with methods such as hand or dip-nets, seining, or trapping with minnow traps (or gee-minnow traps).
b. Manage isolation areas in a manner to avoid multiple salvage events (e.g. do not let water or fish into the isolated area during non-work times).
c. Fish capture will be supervised by a qualified fisheries biologist, with experience in work area isolation and competent to ensure the safe handling of all fish.
d. Conduct fish capture activities during periods of the day with the coolest air and water temperatures possible, normally early in the morning to minimize stress and injury of species present.
e. Monitor the block nets frequently enough to ensure they stay secured to the banks and free of organic accumulation.
f. Electrofishing will be used during the coolest time of day, only after other means of fish capture are determined to be not feasible or ineffective.
   i. Do not electrofish when the water appears turbid, e.g., when objects are not visible at depth of 12 inches.
   ii. Do not intentionally contact fish with the anode.
   iii. Follow NMFS (2000[25] or most recent) electrofishing guidelines, including use of only direct current (DC) or pulsed direct current within the following ranges:
      (a)If conductivity is less than 100 microsecond (µs), use 900 to 1100 volts.
      (b) If conductivity is between 100 and 300 µs, use 500 to 800 volts.
      (c) If conductivity greater than 300 µs, use less than 400 volts.
      (d) Begin electrofishing with a minimum pulse width and recommended voltage, then gradually increase to the point where fish are immobilized.
      (e) Immediately discontinue electrofishing if fish are killed or injured, i.e., dark bands visible on the body, spinal deformations, significant de-scaling, torpid or inability to maintain upright attitude after sufficient recovery time. Recheck

[25] Available at: https://media.fisheries.noaa.gov/dam-migration/electro2000.pdf

machine settings, water temperature and conductivity, and adjust or postpone procedures as necessary to reduce injuries.

(f) If buckets are used to transport fish:

(1) Minimize the time fish are in a transport bucket. Check condition of fish in the bucket frequently.

(2) Keep buckets in shaded areas or, if no shade is available, covered by a canopy.

(3) Limit the number of fish within a bucket; fish will be of relatively comparable size to minimize predation.

(4) Use aerators or replace the water in the buckets at least every 15 minutes with cold, clear water.

(5) Release fish in an area upstream with adequate cover and flow refuge; downstream is acceptable provided the release site is below the influence of construction.

(6) Ensure water levels in buckets is low enough to prevent fish from jumping out of the bucket or cover the bucket with a wet towel

D. Project Design Criteria for Covered Activities

The proposed action must comply with the following Project Design Criteria (PDC), as applicable.

1. Culvert and bridge repair and replacement resulting in improvements for fish passage

The proposed action includes culvert and bridge repair, rehabilitation, and replacement resulting in improved fish passage. Conservation offsets for this activity are not required for those portions of the activity implemented to improve fish passage. Other portions of the projects such as shoreline modification (i.e., bulkheads) may require conservation offsets if those portions of activity would require conservation offsets as described in other PDCs. Project designs must be consistent with the Anadromous Salmonid Passage Facility Design (NMFS 2022) or subsequent version and should follow "Water Crossing Designs Guidelines "Appendix D: Tidally Influenced Crossings" (Barnard et al. 2013). The following action-specific measures must be incorporated into the project design:

a. Crossing replacement. General road-stream crossing criteria include the following

i. Span

(a) Span is determined by the crossing width at the proposed streambed grade.

(b) Single span structures will maintain a clear, unobstructed opening above the general scour elevation that is at least as wide as 1.5 times the active channel width.

(c) Multi-span structures will maintain clear, unobstructed openings above the general scour elevation (except for piers or interior bents) that are at least as wide as 2.2 times the active channel width.

(d) Entrenched streams: If a stream is entrenched (entrenchment ratio of less than 1.4), the crossing width will accommodate the flood prone width. Flood prone width is the channel width measured at twice the maximum bankfull depth (Rosgen 1996).

(e) Minimum structure span in perennial streams is 6 feet.

ii. Bed Material

(a) Install clean alluvium with similar angularity as the natural bed material, no crushed rock.

(b) Bed material shall be sized based on the native particle size distribution of the adjacent channel or reference reach, as quantified by a pebble count (Wolman 1954).

(c) Rock band designs as detailed in Water Crossings Design Guidelines (Barnard et al. 2013) may be used.

(d) Bed material in systems where stream gradient exceeds 3% may be sized to resist movement.

iii. Scour Prism

(a) Designs shall maintain the general scour prism, as a clear, unobstructed opening (i.e., free of any fill, embankment, scour countermeasure, or structural material to include abutments, footings, and culvert inverts). No scour or stream stability countermeasure may be applied above the general scour elevation.

(1) The lateral delineation of the scour prism is defined by the criteria span.

(2) The vertical delineation of the scour prism is defined by the Lower Vertical Adjustment Potential (LVAP) with an additional offset of 2 times D90, as calculated in Stream Simulation: An ecological approach to providing passage for aquatic organisms at road crossings (USDA-Forest Service 2008).

iv. Embeddedness

(a) All abutments, footings, and inverts shall be placed below the thalweg a depth of 3 feet, or the LVAP line with an offset of 2 times D90, whichever is deeper.

(b) In addition to embedment depth, embedment of closed bottom culverts shall be between 30% and 50% of the culvert rise.

(c) In specific cases, embedment may not be feasible due to site constraints, such as bedrock, sewer pipes, buried utilities, etc. If this occurs, the permittee must provide justification to the NMFS staff biologist on why embedment cannot occur at the project site and verify that the proposed design meets fish passage requirements with a NMFS engineer.

v. Bridges

(a) Primary bridge structural elements will be concrete, metal, fiberglass, or untreated timber.

(b) The use of treated wood shall conform with all appropriate PDCs (General Construction Measures 8 and 11).

(c) Riprap may only be placed below bankfull height of the stream when necessary for protection of abutments and pilings. The placement of riprap shall not constrict the bankfull width.

(d) Temporary work bridges must also meet the NMFS 2022.

b. The electronic notification for the above activities shall contain the following:

i. Site sketches, drawings, aerial photographs, or other supporting specifications, calculations, or information that is commensurate with the scope of the action and that show at a minimum the following:

(a) the bankfull width,[26]
(b) the functional floodplain,[27]
(c) any artificial fill within the project area,
(d) the existing crossing to be replaced,
(e) and the proposed crossing.

ii. The name, address, and telephone number of a person responsible for designing this part of the action that NMFS may contact if additional information is necessary to complete the effects analysis.

2. Utilities

This PDC does not include construction or enlargement of any utility to support a new or expanded utility service area. New footings for relocated transmission lines may require conservation offsets.

a. Covered activities include:
   i. Relocating pipes or pipelines used to transport gas or liquids.
   ii. Relocating cables, lines, or wires used to transmit electricity or communications.
   iii. Repair or replacement of pipes, pipelines, cables, lines, wires, and water intakes.
   iv. Underground utility line actions involving excavation, temporary side casting of excavated material, trenching, backfilling of the trench, and restoration of the work site to preconstruction contours and vegetation.
   v. Overhead utility line actions involving long-term vegetation removal, excavation, grading, and installation of footings, foundations, or other structures in riparian and floodplain habitats.
   vi. Construction of new utility corridors where the new corridors replace existing corridors in the same size and footprint. Design utility line water crossings in the following priority, as practicable:
      (a) Design lines, including lines hung from existing bridges to be aerial lines where possible.
      (b) Design directional drilling, boring, and jacking activities to span the channel migration zone and any associated wetland.
      (c) All trenches will be backfilled below the High Tide Line.
      (d) All trenches must be backfilled with native material and capped with clean gravel suitable for fish use
      (e) Any large wood displaced by trenching or plowing will be returned as nearly as possible to its original position, or otherwise arranged to restore habitat functions.

b. Inadvertent return of drilling fluids must be prevented through the following conservation measures:
   i. Have all necessary equipment and supplies on-site to contain an unintended release of drilling mud.

[26] See Appendix C in Barnard et al. 2013, Available at: https://wdfw.wa.gov/sites/default/files/publications/01501/wdfw01501.pdf (Accessed 6/2022)

[27] The area adjacent to a stream that is inundated during periods of flow that exceed the channel capacity the stream has established over time (NMFS 2022).

   ii. The entry and exit locations on all directionally drilled crossings shall have dry (upland) land segments where a frac-out can be easily detected, contained, and remediated.
   iii. On-site visual monitoring by a knowledgeable HDD inspector must occur during construction operations and of the construction area.
   iv. If a frac-out has been detected due to visual signs of surface seepage or loss of circulation/pressure of the drilling fluid, drilling operations will be stopped immediately and will not continue until the response/containment process has been initiated and under control.
   v. The permittee must notify all agencies immediately if an unintended release of drilling mud occurs.
c. A frac-out contingency plan must be in place and implemented to handle potential problems that could arise during the HDD. The plan must be submitted to the NMFS and the Corps and approved by NMFS before in-water work can occur. The plan should include the following site-specific information:
   i. Geotechnical information including soil type, elevation, and depth of the HDD;
   ii. A containment, response, and notification plan
   iii. Clean-up measures
   iv. Restoration and post-construction monitoring plan

3. Stormwater facilities and outfalls

This PDC covers the construction, repair, and replacement of stormwater facilities, including outfalls. Any action covered under this PDC or otherwise causing the discharge of stormwater must meet GCM #13.

4. Shoreline Modifications

Conservation offsets are required for this PDC, except for the installation of soft and hybrid shoreline treatments.

a. Activities included in this PDC include the following:
   i. the repair, replacement, and/or installation of new rock, concrete, untreated wood, and steel sheet pile bulkheads,
   ii. installation of soft and hybrid shoreline techniques. This activity type includes any shoreline modifications within Puget Sound Chinook critical habitat up to HAT including removals above the HTL when proposed as a conservation activity to offset the impacts from a Corps permitted activity.
b. All projects must meet the following criteria:
   i. Work will occur during low tide in the approved WDFW in-water work window and in phases to coordinate with tidal exposure. In the case of concrete, GCM #3 applies, requiring 7 days curing time before tidal inundation. Should new concrete technology develop which has a quicker curing rate, information must be provided as part of the project submittal per GCM 3.
   ii. Prior to high tide, block nets will be set to prevent fish from accessing the area behind the new sheet pile installation.
   iii. A barge or land-based equipment will be used to deliver materials and barge grounding must be avoided at any time.

iv. Bulkhead removals must include submittal and implementation of a riparian vegetation planting plan (RVPP)[28] where riparian vegetation or areas where riparian vegetation, naturally would occur, will be disturbed. The RVPP must be submitted to NMFS and the Corps as part of the SSNP ESA application materials.
v. The installation of new armoring must follow Integrated Streambank Protection Guidelines (Cramer et al. 2002)
vi. Fill all beach depressions created during construction prior to the next inundating tide
vii. Soft Shoreline Treatments Design Criteria
   (a) No or minimal use of artificial structural elements
   (b) Incorporate beach nourishment (sand and small gravel)
   (c) Incorporate riparian plantings or allow for recruitment of native vegetation, including overhanging vegetation
   (d) Incorporate or allow for large wood recruitment, including allowances for small toe erosion protection where necessary, but where the wood does not act as a berm or a crib.
   (e) Large wood may be chained as part of the design.
   (f) Boulders may be incorporated into the design but must not be used as a primary slope stabilizing element.
   (g) Biodegradable fabric and support filters may be used but must be designed and constructed to prevent surface exposure of the material through time.

c. Hybrid Shoreline Treatments Design Criteria
   i. Contains artificial structure that allows for some biological processes to occur (such as forage fish spawning) but inhibits some ecological processes to fully occur (such as suppressing some sediment transport, supply or accretion, but not fully ceasing the process as with hardened approaches.
   ii. Exposed rock, if used, must be discontinuously placed on the beach (i.e., not act as a berm or scour sediments)
   iii. For any individual project, a hybrid approach may not contain more than 30 percent of exposed rock as measured against the length of the project beach.
   iv. Buried rock may be used below grade where necessary to stabilize the toe of the slope and must be covered with sand/small gravel mixes in such a way to minimize net erosion through time.
   v. Hybrid shoreline techniques are an evolving science and individual review and verification of this category by NMFS will evaluate which proposed hybrid techniques will appropriately avoid and minimize impacts and thus be acceptable under this category.
   vi. Incorporate beach nourishment (sand and small gravel) as needed to minimize lowering of beach grade and net erosion.

5. Expand or install a new in-water or overwater structure

Includes all actions necessary to complete installation (e.g., geotechnical surveys, pile driving and excavation grading, or filling). New structures will require submerged aquatic vegetation

[28] For information on riparian planting plans see: https://www.nws.usace.army.mil/Portals/27/docs/regulatory/permit%20guidebook/Mitigation/Riparian%20Planting%20Mit%20Plan%20Requirements%204-20-17.pdf?ver=2017-04-20-180500-970
Last accessed (April 2022)

(SAV) surveys to determine presence or absence and the permittee will describe measures necessary to avoid and minimize impacts to such habitat features. Conservation offsets are needed for activities under this PDC. The Corps recommends that applicants meet the applicable construction specifications of the most current version of Regional General Permit 6 to further minimize impacts on the aquatic environment and to reduce the amount of needed conservation offsets.

a. The structures and activities to install or construct the following structures are included in this PDC:
   i. New mooring buoys
   ii. Mooring dolphin/piles
   iii. Debris booms
   iv. Fender pile(s)
   v. Staircases
   vi. Marine rails
   vii. Boat lift(s) (non-covered),
   viii. Boat ramps. A recreational boat ramp is an inclined plane (usually of concrete or an elevated grated ramp that is supported by piles) extending from the upland into the water that is used to move boats to or from the water and may include a boarding float.
   ix. Residential and community overwater structure (OWS). A residential or community OWS can consist of any combination of fixed pier, elevated walkway, ramp, and float.
b. New mooring buoys and OWSs will not be proposed in areas where water depth is insufficient to prevent the structure from grounding out on substrate during normal low flow or low tide conditions. Floating structures should never "ground out" on the substrate and stoppers/pin piles/feet should hold the structure at least 12 inches above the substrate.
c. If SAV is present within 25-feet of the proposed float, the bottom side of the float must be elevated at least 4 feet above the substrate at low tide to reduce prop scour impacts on SAV.
d. New structures will not be proposed in mitigation sites or other aquatic habitat enhancement, restoration, preservation, or creation sites.
e. The proposed action does not include new covered OWS (e.g., boat house, boat garage, storage shed).
f. Any new in-water residential or community OWS must be designed and built as follows:
   i. Unless the permittee demonstrates that project modifications are necessary to comply with other laws or regulations, e.g., the accessibility guidelines from the Architectural Barriers Act of 1968 (ABA) or the Americans with Disabilities Act of 1990 (ADA).
   ii. To the maximum extent practicable, the location of the proposed in-water or overwater structures should not be in areas occupied by or determined to be suitable for sensitive habitat (e.g. SAV, salt marsh, intertidal flats).
   iii. Piles:
      (a) In addition to float and pier support piles, a maximum of 2 moorage piles may be installed.

(b) Use the smallest diameter piles and the fewest number necessary for support of the structure to minimize pile shading, substrate impacts, and impacts to water circulation.
(c) Pier support pilings must be spaced a minimum distance of 20 feet apart unless site specific conditions or engineering needs dictate a shorter distance. Piles in forage fish spawning habitat: Pier support pilings in forage fish spawning habitat must be spaced a minimum distance of 40 feet apart unless site specific conditions or engineering needs dictate a shorter distance.
(d) All pilings and mooring buoys must be fitted with devices to prevent perching by piscivorous birds.

iv. Mooring Buoys:
(a) Anchor lines must not rest or drag on the substrate. A midline float must be installed to prevent this.
(b) Anchors should be helical screw or another type of embedded anchor. Only if the substrate prohibits use of embedded anchors may an alternative anchor (i.e., concrete block) be used.
(c) If an embedded anchor cannot be used and a concrete anchor is needed, calculations showing that the anchor will hold without dragging/breaking during storm events is required. This analysis should include the size of the vessel and the dry weight/dimensions of the anchor.
(d) No other buoys may be anchored within a 117 foot radius of the proposed buoy. Note: This requirement can be waived up to no more than 3 other buoys within a 117-foot radius of the proposed buoy provided water quality impacts to shellfish are minimized. Show all existing buoys within a 117- foot radius of the proposed buoy on the project drawings.

v. Floats:
(a) Floats must have a minimum of 50 percent grating and all grating must have a minimum of 60 percent open space (WAC 220-110-300).
(b) Floats may be held in place with lines anchored with a helical screw or “duckbill” embedded anchor or piles.

vi. Grating:
(a) Piers, gangway ramps, and stairs must be fully grated.
(b) Grating openings should be oriented lengthwise in the east-west direction to the maximum extent practicable.

vii. Skirting and other continuous protective bumper material that may impede light penetration beneath an overwater structure may not extend below the bottom edge of a float frame or pier.

viii. Structures will be placed with as much horizontal and vertical distance to SAV as possible to minimize shading impacts, to allow for greater circulation, and to reduce impacts from boat maneuvering, grounding, and propeller damage (prop scarring).

ix. All synthetic float material must be permanently encapsulated to prevent breakup into small pieces and dispersal in water.

x. Up to two watercraft lifts may be installed at a single-use overwater structure and up to four may be installed at a joint-use structure.

xi. A maximum of 2 additional piles may be used to attach a watercraft lift/grid to the piles used for anchoring the floats.

xii. A new boat ramp must be constructed as follows:
   (a) Concrete ramps must use pre-cast concrete slabs below High Tide Line, although the slabs may be cast-in-place if completed in the dry.
   (b) Boarding floats for a ramp may be allowed to ground out only on the ramp surface.
   (c) The extent, size, and amount of rock used to prevent scouring, down-cutting, or failure at the boat ramp will be determined by a professional engineer.
   (d) For elevated boat ramps, debris will be removed from under the boat ramp for the life of the project. While man-made debris (e.g., Styrofoam, fishing line, etc.) should be disposed of properly in an upland location, organic material, including wood and marine algae, will be moved to the beach down drift of the structure.

xiii. A new marine rail must be constructed as follows:
   (a) A residential property can have only one structure located within the intertidal area, a marine rail or an overwater structure, but not both.
   (b) A marine rail has to be at least 20 feet long or an overwater structure, but not both
   (c) Support a marine rail with as few piles as practicable.

xiv. A new staircase must be constructed as follows:
   (a) Stairway landings and steps must be entirely grated with either multi-directional grating with 40% open space or square grating with 60% open space.

xv. A new tram must be constructed as follows:
   (a) For anchoring of tram cables or footings for stairs: No more than one cubic yard of fill can be used for each footing or anchor. The number and size of footings and anchors must be minimized.

6. Repair or replace an existing structure

Conservation offsets are required for repair or replacement of the structural elements being repaired or replaced.

a. Eligible structures include:
   i. aids to navigation,
   ii. house boats,
   iii. boat houses, covered boat houses, boat garages,
   iv. boat ramps (commercial, public, or private),
   v. breakwaters,
   vi. buoys and mooring structures
   vii. commercial, industrial, and residential piers or
   viii. wharfs, port, industrial, and marina facilities
   ix. piers, ramps, and floats,
   x. dolphins,
   xi. float plane hangars,
   xii. floating storage units,
   xiii. floating walkways,
   xiv. debris booms,
   xv. groins, jetties.

b. Design criteria for these structures include:
   i. Boat ramps should be elevated in sediment transport zones, to the maximum extent practicable.
   ii. All concrete boat ramps must consist of pre-cast concrete slabs below ordinary high water, although the slabs may be cast-in-place if completed in the dry. The extent, size, and amount of rock used to prevent scouring, down-cutting, or failure at the boat ramp will be determined by a professional engineer.
   iii. All synthetic flotation material must be permanently encapsulated to prevent breakup into small pieces and dispersal in water.
   iv. Refer to GCM #11 for the removal of treated wood other than piles.
   v. Decking replacement on residential or community pier and ramps over 33% or over 250 square feet must be entirely grated with 60% open area (compliant with WAC 220-660-390)
   vi. Any float on a residential or community OWS must have a minimum of 50 percent grating and all grating must have a minimum of 60 percent open space, unless the permittee demonstrates that modifications are necessary to comply with other laws or regulations, e.g., the accessibility guidelines from the Architectural Barriers Act of 1968 (ABA) or the Americans with Disabilities Act of 1990 (ADA).
   vii. All float pilings and mooring buoys must be fitted with devices to prevent perching by piscivorous birds.
   viii. Any existing structure that is relocated in a marina must remain within the existing overall marina footprint.
   ix. For structures with impervious surfaces, refer to GMC #13 for stormwater treatment requirements.

c. For marine terminals, the proposed action includes, replacing existing pilings, fender piles, group pilings, walers, fender pads, and debris booms; installing new mooring dolphins and structural pilings; and replacing or repairing, commercial or industrial piers or wharfs.

d. For marinas, the proposed action includes replacing, repairing piles, piers, ramps, and floats, and moving or rearranging piles and floats, provided that the character and size of the floats, and the existing overall footprint of the marina do not change. Rearrangement of overwater structure elements cannot result in impacts greater than those caused by the existing structure. For example, moving structures to areas with higher SAV cover would not be covered under this category.

7. Minor Maintenance of an Existing Structure

The structure must remain the same size and within its current footprint. This category of activities does not require conservation offsets.

a. The use and purpose of the structure (e.g., recreation, commercial, or industrial use) must not change.

b. Qualifying maintenance activity types are:
   i. Pile resets
   ii. Capping of piles
   iii. Replacement of rubber strips (but no tires)
   iv. Replacement of float stops
   v. Encapsulation of flotation material

vi. Height extension of existing pilings
vii. Replacement of fender piles that do not contribute to the structural integrity of the structure.
viii. Replacing well-functioning solid decking with grated decking.[29] Replacement grating must have a minimum of 50 percent grating and all grating must have a minimum of 60 percent open space, unless the permittee demonstrates that modifications are necessary to meet a public purpose and need, e.g., to comply with accessibility guidelines from the Architectural Barriers Act of 1968 (ABA) or the Americans with Disabilities Act of 1990 (ADA).

8. Repair, replace, expand or install a new aid to navigation, scientific measurement device, or tideland marker

Includes all actions necessary to complete installation of the above structures (e.g., geotechnical surveys, pile driving and excavation above HAT, grading, or filling). Conservation offsets are not required for this category of activity.

a. Tideland markers, and navigational aids must be fitted with devices to prevent perching by piscivorous birds.

9. Dredging for vessel access

Dredging to maintain vessel access to existing authorized piers, ramps, floats, wharfs, mooring structures, marinas, marine terminals, or boat ramps by restoring the previously authorized dredge prism, provided that any dredged materials are suitable, verified, and approved for in-water, upland, or ocean disposal. Additionally, the subsequent cut surface must be suitable, verified, and approved to not pose a contaminant risk, as determined by the Dredged Material Management Office. The purpose of this action is to keep previously authorized dredging prisms functional but to avoid deepening or expanding those areas. The proposed action PDC does not include any modification that changes the character, scope, size, or location of the project area or previously authorized dredge prism. This action includes the ability to issue multiple year permits for maintenance to ensure that vessel access is not interrupted by normal changes in estuarine conditions during a reasonable interval between dredging events. As described below, applicants may dredge by hydraulic suction, clamshell, or open bucket or propeller wash or excavator. This action does not include proposals for new dredging areas or dredging associated with the Federal Navigational Channel maintenance. Dredging will require SAV surveys to determine presence or absence of aquatic vegetation and the permittee will describe how the permittee plans to avoid and minimize impacts to such habitat features. The following conditions apply:

a. Conservation offsets are required for activities covered by this PDC.
b. The dredging must not alter the character, scope, size, or location of the project area or previously authorized dredge prism.
c. Dredging activities will be sequenced or phased to minimize the extent and duration of in-water disturbances.
d. If dredging will occur by hopper dredge or hydraulic cutterhead, the draghead or cutterhead will remain on the bottom to the greatest extent possible and only be raised 3

[29] This does not include replacement of any framing or support features for the grating.

feet off the bottom when necessary, to minimize water turbidity and the potential for entrainment of organisms.

e. When using dredge material for beach nourishment follow PDC #13 (Beach nourishment).
f. For mechanical dredging operations, the following techniques are recommended:
    i. Use an environmental bucket or covered bucket, where practicable.
    ii. Lower the bucket slowly through the water column.
    iii. Close the bucket as slowly as possible on the bottom. Do not overfill the bucket.
    iv. Hoist the load very slowly.
    v. If dewatering is permissible, pause the bucket at the water surface to minimize distance of discharge.
    vi. Ensure that all material is dumped into the barge from the bucket before returning for another bite.
    vii. Do not dump partial or full buckets of material back into the water.
g. The type of material to be dredged dictates the acceptable and feasible disposal practice, in order to reduce turbidity in the receiving waters:
    i. Placement activities at designated Dredged Material Management Program (DMMP)[30] sites are performed in accordance with the Site Management and Monitoring Plan developed under 40 CFR 228.9 and with use restrictions specified as part of the designation for these sites. At non-dispersive sites, material is dispersed as thinly and evenly as possible to minimize mounding and reduce impacts to marine organisms.
    ii. The disposal vessel will remain within the boundaries of the disposal site during a disposal event.
    iii. The disposal vessel should maintain a continuous speed of at least 2 knots, but no greater than 6 knots, when possible, during a disposal event.
    iv. If sediment sampling determines that dredged material is not acceptable for unconfined, in-water placement, then a suitable alternative placement plan will be developed in cooperation with NMFS, EPA, Washington Department of Ecology and other agencies, as applicable.
    v. If in-water disposal is not feasible due to the unsuitability of sediments, upland disposal shall be required. Upland disposal will also be considered if dredging occurs in the estuary. The permittee is responsible for permitting any beneficial use upland placement, if proposed.
    vi. Upland disposal sites will have dikes or other facilities to manage any return water. Return water will meet state water quality standards.

10. Dredging and debris removal to maintain functionality of culverts, water intakes, or outfalls

a. Restore lost or impaired function of a culvert, water intake, or outfall, including addition of a fish screen that meets NMFS' criteria (2011a or most recent version) for any water intake or point of diversion. This action includes the ability to issue multiple year permits for maintenance to ensure that non-navigation functionality is not interrupted by normal changes in marine or estuarine conditions during a reasonable interval between dredging

[30] Information available at: https://www.nws.usace.army.mil/Missions/Civil-Works/Dredging/

or debris removal events. The purpose of this action is to clear obstructing, clogging, or blocking material and restore full operation to the existing culvert, intake, or outfall. Therefore, dredging is expected to only be of a limited footprint or volume. Dredging will require SAV surveys in marine work areas to determine presence of aquatic vegetation. The permittee shall provide a plan to demonstrate how the action will avoid and minimize impacts. NMFS review and verification is required per Section B.5. (Program Administration – NMFS Review and Verification). Conservation offsets are not required for this PDC.

b. When dredging or excavating to maintain the functionality of a culvert, intake, or outfall, the following conditions apply:
   i. Dredging or excavation will be limited to the greatest extent possible. Dredging or excavation can only occur at water intake or divisions with a fish screen meeting NMFS fish screen criteria and NMFS fish passage criteria. Dredging or excavation to maintain functionality of a water intake or diversion without a screen meeting NMFS criterion will require an individual consultation.
   ii. The dredging must not alter the originally designed character, scope, size, or location of the project area.
   iii. All dredged or excavated materials and subsequent leave surface (newly exposed sediment) must be suitable and verified for in-water disposal/exposure using newly acquired or historical data based on criteria in the Sediment Evaluation Framework (RSET 2018).

11. Habitat Enhancement Activities

The purpose of this category is to enhance nearshore habitat for ESA listed species and their designated critical habitat. In many cases, we expect this PDC to be used to cover projects undertaken to achieve conservation offsets for projects that would otherwise result in a net loss of nearshore habitat. This PDC does not require conservation offsets, however benefits may be quantified using the Conservation Calculator. Activities covered under this PDC may be standalone projects, or may be proposed and undertaken in conjunction with other projects or activities covered under SSNP within a single permit application.

a. Wetland, shoreline, tidal stream, and floodplain restoration. This conservation action category includes projects focused on restoring degraded wetlands; disconnected floodplains, and shorelines. In all cases, restoration of the resource function and habitat quality is the primary purpose of the action. This category includes:
   i. Enhancement or restoration of wetland, shoreline or floodplain functions and values.
   ii. Re-establishment of historic floodplain extent through removal of fill from within the historic 100-year floodplain.
   iii. Enhancement of floodplain habitat quality through removal of anthropogenic structures, infrastructure, debris, or water control features (weirs, dams, etc.) located wholly or partially within the floodplain.

b. In-water or over-water structure, rubble, or derelict vessel removal. Restore impaired in-water and riparian habitat through the removal of untreated and chemically treated wood pilings, piers, vessels, floats, derelict fishing gear, as well as similar structures or rubble comprised of plastic, concrete, and other materials.
   i. For pile removal, refer to GCM #9 or #10.

ii. For removal of derelict vessels:

(a) Fuel, oil, and other toxic materials will be removed from sunken vessels prior to being moved or removed and transported according to state and federal regulations to an approved hazardous waste disposal facility.

(b) Install a containment boom and floating silt curtain around the vessel to contain any debris, turbidity, and remnant oils.

(c) Use a crane barge or lift bags to lift and remove the sunken vessel; lifting slings will be placed around the vessel and pumps will dewater the vessel while it is lifting.

(d) In-water work must be conducted during daylight hours.

(e) Intact vessels will be brought to shore and dismantled on land, per environmental regulations, and the pieces will either be recycled or disposed of at an approved landfill.

(f) If the process of removing a derelict vessel will damage habitat more than its presence, the derelict vessel will not be removed or the derelict vessel may not be removed in its entirety.

(g) Photos and/or a map of the locations and sizes (sq ft) of vessels should be provided to the Corps and NMFS from the Permittee.

12. Set-back or removal of existing bulkheads, tidegates, berms, dikes, or levees

The purpose of this category is to enhance nearshore habitat for ESA listed species and their designated critical habitat. In many cases, we expect this PDC to be used to cover projects undertaken to achieve conservation offsets for projects that would otherwise result in a net loss of nearshore habitat. Activities covered under this PDC may be standalone projects, or may be proposed and undertaken in conjunction with other projects or activities covered under SSNP within a single permit application.

Rehabilitate or restore connections between channels and floodplains by increasing the distance that existing berms, dikes or levees are set landward from active channels or wetlands. Conservation offsets are not needed for the removal of tidegates, bulkheads, levees, dikes, or berms. However, setback of structures may require conservation offsets depending on the location of the new (set back) structure. Impacts and benefits may be quantified using the Conservation Calculator

a. Removal of all types of bulkheads (including creosote-treated timber bulkheads)
b. Repairing or restoring estuary functions shall be completed before dikes/levees are breached and the project area is flooded.
c. Channel construction in tidally influenced streams may be done to recreate channel morphology based on aerial photograph interpretation, literature, topographic surveys, and nearby undisturbed channels. Channel dimensions (width and depth) shall be based on measurements of similar types of channels and the drainage area.

Note: Many of these elements involving the discharge of dredged and fill material (i.e., filling, grading, leveling waters of the U.S.) need to be permitted by the Corps. Therefore, the permit application must include all of the applicable elements in the project description.

13. Beach nourishment

The purpose of this category is to enhance nearshore habitat for ESA listed species and their designated critical habitat. In many cases, we expect this PDC to be used to cover projects undertaken to achieve conservation offsets for projects that would otherwise result in a net loss of nearshore habitat. This PDC does not require conservation offsets, however benefits may be quantified using the Conservation Calculator. Activities covered under this PDC may be standalone projects, or may be proposed and undertaken in conjunction with other projects or activities covered under SSNP within a single permit application.

Activities should meet the following criteria:

a. Projects may use sediment harvested from previously permitted dredging activities and/or gravel upland sources. The material should be similar in size to undisturbed neighboring locations with similar beach morphologies. Dredged material must be suitable[31] for in-water disposal or placement where it will periodically be in contact with water. Sediment may be placed in the high tide zone of the beach, where it is likely to be subsequently reworked and redistributed by wave action.
b. Conduct topographic and bathymetric profile surveys of the beach and offshore within the project and control areas. Pre- and post-construction surveys shall be conducted no more than 90 days before construction commences and no more than 60 days after construction ends. Surveys should be submitted to NMFS with a copy sent to the Corps Project Manager and NWS-ESA-Team@usace.army.mil.
c. Placement of beach nourishment will follow WDFW Marine Shoreline Design Guidelines (MSDG), 2014. (https://wdfw.wa.gov/sites/default/files/publications/01583/wdfw01583.pdf#page=123&zoom=100,68,96)
d. To meet WDFW mitigation requirements for hydraulic project approval (HPA), up to 25 cubic yards of suitable material may be placed to create or improve fish habitat and nearshore environment as follows:
    i. Only clean, suitable material may be placed.
    ii. The beach will not contain any pits, potholes, or large depressions, and all natural beach complexity that was necessary to remove will be repositioned or replaced in the original locations immediately following completion of work.
    iii. When placing material in areas known to have forage fish spawning, permittee will adhere to WDFW timing windows protective of forage fish.
    iv. When placing material on known surf smelt spawning beaches a spawning survey will be conducted prior to placing material.
    v. Stockpiling will not occur below the HTL.

Note: Many of these elements involving the discharge of dredged and fill material (i.e., filling, grading, leveling waters of the U.S.) need to be permitted by the Corps. Therefore, the permit application must include all of the applicable elements in the project description.

[31]Northwest Regional Sediment Evaluation Team (RSET). 2016. Available at: https://www.epa.gov/sites/default/files/2016-07/documents/sediment_evaluation_framework_for_the_pacific_northwest_2016.pdf

14. Sediment/Soil Remediation

Dredging, excavation, capping, or other methods of removing or isolating contaminated sediments from aquatic habitats that are performed, ordered, or sponsored by government agency with established legal or regulatory authority. This authorization includes actions to remediate contaminants bound in sediments, tidal and seasonally inundated soils, upland soils, and groundwater. No conservation offsets are required for these activities. The following remedial activities are covered:

a. Dredging, excavation, or similar methods to remove contaminants and contaminated soils/sediments,
b. Capping or similar methods to isolate or sequester contaminants from ecological receptors, and
c. Transport and disposal of contaminated equipment, materials, media, water, soils, sediments.
d. This category also includes actions necessary to complete geotechnical surveys, bathymetric mapping, sediment collection for analytical testing, and other assessment and planning methods that are minimally disturbing of soils/sediments. Minimally disturbing activities include pile removal from sediments that are contaminated.
e. When removing piles from contaminated sediments use the general construction measures outlined in GCM #9 and #10.
f. Place carbon-amended sand around the base of each pile to backfill the void post-removal.
g. Proposed actions will:
    i. Include BMPs to limit re-suspension of contaminants/ contaminated sediments during dredging activities.
    ii. Include best available BMPs to preclude contaminated groundwater from interfacing with a receiving water supporting ESA-listed species or habitat.
    iii. Minimize impacts to in-water habitat from capping actions by including cap features to promote long-term habitat development (e.g., top dressing cap with round appropriately sized, round, river rock and gravels).

Note: Many of these elements involving the discharge of dredged and fill material (i.e., filling, grading, leveling waters of the U.S.) need to be permitted by the Corps. Therefore, the permit application must include all of the applicable elements in the project description.

2. ENDANGERED SPECIES ACT BIOLOGICAL OPINION AND INCIDENTAL TAKE STATEMENT

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

The Corps determined the proposed programmatic action is not likely to adversely affect the Central America or Mexico humpback whales (*Megaptera novaeangliae*), the southern DPS of green sturgeon (*Acipenser medirostris*) and the southern DPS of eulachon and their critical habitat Our concurrence is documented in the “Not Likely to Adversely Affect” Determinations section (Section 2.13).

2.1. Analytical Approach

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

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

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

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

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

- Evaluate the rangewide status of the species and critical habitat expected to be adversely affected by the proposed action.
- Evaluate the environmental baseline of the species and critical habitat.
- Evaluate the effects of the proposed action on species and their habitat using an exposure-response approach.
- Evaluate cumulative effects.
- In the integration and synthesis, add the effects of the action and cumulative effects to the environmental baseline, and, in light of the status of the species and critical habitat,

analyze whether the proposed action is likely to: (1) directly or indirectly reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species, or (2) directly or indirectly result in an alteration that appreciably diminishes the value of critical habitat as a whole for the conservation of a listed species.

- If necessary, suggest a reasonable and prudent alternative to the proposed action.

SSNP requires projects authorized under this programmatic action do not result in a net-loss of nearshore habitat quality. The NMFS' Puget Sound Nearshore Calculator (Calculator) is an available tool permittees can use to ensure no-net loss of nearshore habitat quality.

This opinion is consistent with the ESA, its implementing regulations 50 CFR 402, and *A Memorandum Between the Department of the Army (Civil Works) and the National Oceanic and Atmospheric Administration (NOAA)* (Joint Memo). The Joint Memo describes how NOAA and the Corps evaluate the effects of projects involving existing structures on listed species and designated critical habitat in Endangered Species Act Section 7 consultations. NMFS and the Corps have agreed that for purposes of analyzing the effects of repairing and replacing existing structures, the following assumptions are appropriate and will be used by NMFS in evaluating the effects of the action.

For purposes of this analysis, we must differentiate between effects that are part of the environmental baseline and effects that would not occur but for the proposed action and are reasonably certain to occur. To do so, the agencies assume the following for the purpose of this biological opinion[32] for projects that include the repair and replacement of existing structures, thereby extending the life of all or part of those structures:

- The proposed repair and replacement structures are in compliance with state and federal requirements and received a Corps permit when they were originally built. Or, the structures were built at a time when Corps authorization was not required (i.e., prior to the enactment of the Clean Water Act in 1972).
- Corps authorization for the construction of structures, including fill, typically authorize the permitted structures to exist indefinitely with no expiration date cited. 33 C.F.R § 325.6. However, pursuant to general condition 2 at 33 C.F.R. Part 325, Appendix A, and Nationwide Permit General Condition Number 14, permittees are required to maintain the authorized structure or fill in "good condition." For the structure to remain in compliance with the Corps permit, at some point(s) during the life of the structure it is reasonably certain that the owner will seek a future Corps permit(s) to repair or replace some or all components of the structure.
- Future maintenance that will require a Corps permit is not part of this proposed action and thus effects stemming from any work performed under some future request for authorization are not covered, nor analyzed by, this consultation.

[32] Although these assumptions may be appropriate for in-water, near-water, and overwater structures in the Salish Sea, the assumptions may not be appropriate for other types of structures or the same types of structures in other locations.

- The Corps has the discretion to grant or deny requests for Regulatory permits to conduct activities that would be covered under SSNP. *See* 33 CFR 325.2(b)(5); 325.8; 40 CFR 230.10(b)(3).
- Applicants typically seek Corps authorization to repair or replace existing structures before their structure is in need of major repairs, but not at a time before repairs are anticipated that would result in unnecessary work or cost. Since applicants will have sought authorization for projects that will be covered under SSNP, it is reasonably certain that the structure will be in need of that work at the time of the permit request, or within the next few years. For purposes of this consultation, and absent information to the contrary, we assume that the structures to be repaired or replaced under SSNP could have existed (without the proposed repair or replacement) and would have caused the same type of effects for an additional 10 years. This timeframe is based on the agencies' experience working with applicants and with input from marine industry stakeholders while working to implement the mitigation calculator that supported the Structure in Marine Waters /RGP-6 Programmatic (NMFS 2016a) and accounts for the time an permittee typically could have delayed seeking the immediate permit.
- Any effects that the structure would have caused during the above-described 10-year time period will be considered part of the environmental baseline. As such, for most projects, the effects analysis would consider any benefits of removing the structure 10 years early.[33]
- Nearly all repair or replacement projects covered by SSNP will extend the life of all or part of existing structures. Thus, the effects of the action include the impacts caused by the repaired or replaced structures during its newly extended life. Here, based on what we know about the life of the kinds of structures covered under SSNP, we assume the proposed action will extend the life of the structure, or the part of the structure being repaired or replaced, as follows[34]:
    - Over and in water structures: 40-years
    - Shoreline stabilization (marine bulkheads): 50-years
- When quantifying the enduring effects of the proposed activity caused by any extended life and any required offsets, the agencies will evaluate effects and offsets based on the part of the structure being repaired or replaced.
- We do not assume that the existing structures would have "disappeared" at the 10-year mark; rather, we acknowledge that in many cases it would take much longer for structures to degrade in the marine nearshore environment and the habitat to naturally revert to full function if the owner ceased to perform any maintenance (or repair or replacement). Such a "degradation period" is not part of our effects analysis when determining what would not occur but for the proposed action and is reasonably certain to occur for a number of reasons.

[33] The "10-year" time period is a default assumption for this consultation. In some cases where there is immediate need of replacement or repair (e.g., in the upcoming in-water work window, there would be no remaining life to consider. In other cases (e.g., where an applicant is upgrading a relatively new structure, say one less than 10 years old) it may be reasonable to assume the applicant could have waited longer than 10 years to seek the authorization to work on the existing structure.

[34] The assumed duration of the extended life is based on the agencies experience implementing the programmatic consultation for RGP6 CITE, as well as input from consultants that regularly assist applicants through the permitting processes. Depending on design, engineering, and materials, these periods could be shorter or longer.

- First, the range of potential outcomes that might happen absent maintenance is exponential, to the point it is not reasonable to assume them all, nor is there currently enough data or analysis that would support such an analysis. The range of possible scenarios could result in impacts associated with a degrading structure over time that would be both negative (e.g., decomposing creosote impacts to water quality) and positive (e.g., overwater cover is no longer obstructing migration).
- Second, it is not reasonable to assume that the structures would be left to fall into disrepair given the preponderance of evidence (including the thousands of redevelopment consultations that have occurred with the Corps since salmon were listed) that demonstrate that owners of nearshore, in- and overwater structures do at some point in time apply for Corps permit to maintain structures in good condition. Moreover, when the Corps seeks ESA consultation through SSNP, it will do so on behalf of permittees who have demonstrated a desire to maintain their structures by applying for a Corps permit. As noted above, Corps' permits require owners to maintain structures (or fill) in "good" condition. Thus it is reasonable to assume that that regular maintenance is likely to occur.
- Third, any impacts that might be caused by a theoretical "degradation" period are still part of the calculus, but the proposed action has moved them out in time to occur after any newly extended life. Because the basic consequence of the activities that will be covered by SSNP is to extend the life part or all of the existing structure, any effects of a possible degradation, instead of occurring now, will occur, if at all, after that newly extended life. In that way, the potential effects that might occur should the permittee cease maintenance are still part of the environmental baseline.

2.2. Rangewide Status of the Species and Critical Habitat

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

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

2016). Rain-dominated watersheds and those with significant contributions from groundwater may be less sensitive to predicted changes in climate (Tague et al. 2013; Mote et al. 2014).

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 (Mantua et al. 2010; Isaak et al. 2012). 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; Winder and Schindler 2004; Raymondi et al. 2013). Higher temperatures are likely to cause several species to become more susceptible to parasites, disease, and higher predation rates (Crozier et al. 2008; Wainwright and Weitkamp 2013; Raymondi et al. 2013).

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 1.0-3.7ºC by the end of the century (IPCC 2014). Habitat loss, shifts in species' ranges and abundances, and altered marine food webs could have substantial consequences to anadromous, coastal, and marine species in the Pacific Northwest (Tillmann and Siemann 2011; Reeder et al. 2013).

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.

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. 2014). 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). In fact, most Washington State models predict average temperatures in Washington State to increase 0.1-0.6ºC per decade (Mote and Salathé 2009). Warmer air temperatures will lead to more precipitation falling as rain rather than snow. As the snow pack diminishes, seasonal hydrology will shift to more frequent and severe early large storms, changing stream flow timing and increasing peak riverflows, which may limit salmon survival (Mantua et al. 2009). The largest driver of climate-induced decline in salmon and steelhead populations is projected to be the impact of increased winter peak flows, which scour the streambed and destroy salmonid eggs (Battin et al. 2007; Mantua et al. 2009).

Decreases in summer precipitation of as much as 30 percent by the end of the century are consistently predicted across climate models (Mote et al. 2014). Precipitation is more likely to occur during October through March, less during summer months, and more winter precipitation will be rain than snow (ISAB 2007; Mote et al. 2013). 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 rise resulted in 3.5-5.3ºC increases in Columbia Basin streams and a peak temperature of 26ºC 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).

The NOAA's Northwest Fisheries Science Center (NWFSC, NWFSC 2015) reported that climate conditions affecting Puget Sound salmonids were not optimistic, and recent and unfavorable environmental trends are expected to continue. A negative pattern in the Pacific Decadal Oscillation[35] has recently emerged, which adds uncertainty to the short-term duration of warming trends. However, the long-term trends of climate change and other environmental indicators suggest the continuation of warming ocean temperatures; fragmented or degraded freshwater spawning and rearing habitat; reduced snowpack; altered hydrographs producing reduced summer river flows and warmer water; and low marine survival for salmonids in the Salish Sea (NWFSC 2015). Overall, the marine heat wave in 2014-2016 had the most drastic impact on marine ecosystems in 2015, with lingering effects into 2016 and 2017. Conditions had somewhat returned to "normal" in 2018, but another marine heat wave in 2019 again set off a series of marine ecosystem changes across the North Pacific. One reason for lingering effects of ecosystem response is due to biological lags. These lags result from species impacts at larval or juvenile stages, which are typically most sensitive to extreme temperatures or changes in food supply. It is only once these species grow to adult size or recruit into fisheries that the impact of the heat wave is apparent (Ford 2022). Any rebound in VSP parameters for PS steelhead are likely to be constrained under these conditions (NWFSC 2015; Ford 2022).

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 (McMahon and Hartman 1989; Lawson et al. 2004).

[35] https://www.ncdc.noaa.gov/teleconnections/pdo/.

Mauger et al. (2015) reviewed the expected effects of climate change on the Puget Sound marine ecosystem. They identify warmer water temperatures, loss of coastal habitat due to sea level rise, ocean acidification, changes in water quality and freshwater inputs, more frequent algal blooms, and increased erosion from wave action as likely impacts of future climate change.
Recent modeling research has shown variation in the impacts of marine warming on fall-run Chinook salmon distribution depending on stock, resulting in future regional declines or increases in salmon abundance. Shelton et al. (2020) used a Bayesian state-space model to model ocean distribution of fall-run Chinook salmon stocks in the Northwest Pacific, paired with data on sea surface temperature associated with each stock and future ocean climate predictions to predict future distribution of Chinook salmon related to changing sea surface temperature in 2030-2090. In warm years (compared to cool) Klamath, Columbia River (upriver bright run, lower, middle), and Snake River stocks shifted further North, while California Central Valley stock shifted south. Notably, Columbia River and Snake River fall-run Chinook salmon are in the top 10 priority stocks for SRKWs (NMFS and WDFW 2018). Predicted future shifts in distributions due to warming led to future increases in ocean salmon abundance off northern British Columbia and central California, minimal changes off Oregon, Southern British Columbia, and Alaska, and declines in abundance off Washington and northern California (Shelton et al. 2020).

In a broader view, data overwhelmingly indicate the planet is warming (IPCC 2014), which poses a threat to many species. Climate change has the potential to impact species abundance, geographic distribution, migration patterns, timing of seasonal activities (IPCC 2014), and species viability into the future. Changes in climate and ocean conditions happen on several different time scales and have had a profound influence on distributions and abundances of marine and anadromous fishes.

In marine habitat, scientists are not certain of all the factors impacting salmon and steelhead survival but several ocean-climate events are linked with fluctuations in steelhead health and abundance such as El Niño/La Niña, the Aleutian Low, and coastal upwelling (Pearcy and Mantua 1999). Steelhead, along with Chinook and coho salmon, have experienced tenfold declines in survival during the marine phase of their lifecycle, and their total abundance remains well below what it was 30 years ago[36]. The marine survival of coastal steelhead, as well as Columbia River Chinook and coho salmon, do not exhibit the same declining trend as the Salish Sea populations. Specifically, marine survival rates for steelhead in Washington State have declined in the last 25 years with the PS steelhead populations declining to a greater extent than other regions (i.e., Washington Coast and Lower Columbia River). Abundance of PS steelhead populations is at near historic lows (Moore et al. 2014). Climate changes have included increasing water temperatures, increasing acidity, more harmful algae, the loss of forage fish and some marine commercial fishes, changes in marine plants, and increased populations of some marine mammals (i.e. seals and porpoises) (LLTK 2015). Preliminary work conducted as part of the Salish Sea Marine Survival Project reported that approximately 50 percent of the steelhead smolts that reach the Hood Canal Bridge did not survive in the 2017 and 2018 outmigration years. Of the steelhead that did not survive, approximately 80 percent were consumed by predators that display deep diving behavior, such as pinnipeds (Moore and Berejikian 2019).

[36] Long Live the Kings 2015: http://marinesurvivalproject.com/the-project/why/

Climate change plays a part in steelhead mortality, but more studies are needed to determine the specific causes of this marine survival decline in Puget Sound.

Evidence suggests that marine survival among salmonids fluctuates in response to 20 to 30-year cycles of climatic conditions and ocean productivity. Naturally occurring climatic patterns, such as the Pacific Decadal Oscillation, El Niño and La Niña events, and North Pacific Gyre Oscillation, can cause changes in ocean productivity that can affect productivity and survival, of salmon (Mantua et al. 1997; Francis and Hengeveld 1998; Beamish et al. 1999; Hare et al. 1999; Benson and Trites 2002; Dalton et al. 2013, Kilduff et al. 2014), affecting the prey available to SRKWs. (Though relationships may be weakening, see Litzow et al. 2020). Prey species such as salmon are most likely to be affected through changes in food availability and oceanic survival (Benson and Trites 2002), with biological productivity increasing during cooler periods and decreasing during warmer periods (Hare et al. 1999; NMFS 2008a). Also, range extensions were documented in many species from southern California to Alaska during unusually warm water associated with "The Blob" in 2014 and 2015 (Bond et al. 2015; Di Lorenzo and Mantua 2016), and past strong El Niño events (Pearcy 2002; Fisher et al. 2015).

The frequency of these extreme climate conditions associated with El Niño events or "blobs" are predicted to increase in the future with climate change (greenhouse forcing) (Di Lorenzo and Mantua 2016) and therefore, it is likely that long-term anthropogenic climate change would interact with inter-annual climate variability. Multiple modeling studies have predicted increases in the frequency of extreme ENSO events and increased ENSO variability due to climate change (Cai et al. 2014, 2015, 2018, Wang et al. 2017). Modeled projections of future marine heat waves similar to the "blob" have predicted decreases in salmon biomass and distribution shifts for salmon, particularly sockeye, in the Northeast Pacific (Cheung and Frölicher 2020). Evidence suggests that early marine survival for juvenile salmon is a critical phase in their survival and development into adults. The correlation between various environmental indices that track ocean conditions and salmon productivity in the Pacific Ocean, both on a broad and a local scale, provides an indication of the role they play in salmon survival in the ocean.

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 percent increase in acidity is projected by the end of this century in all but the most stringent CO_2 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 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 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 (Tillmann and Siemann 2011; Reeder et al. 2013). 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 (Ford 2022). 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 (Tillmann and Siemann 2011; Reeder et al. 2013).

Climatic conditions affect salmonid abundance, productivity, spatial structure, and diversity through direct and indirect impacts at all life stages (e.g., ISAB 2007, Lindley et al. 2007, Crozier et al. 2008; Moyle et al. 2013, Wainwright and Weitkamp 2013). Studies examining the effects of long-term climate change to salmon populations have identified a number of common mechanisms by which climate variation is likely to influence salmon sustainability. These include direct effects of temperature such as mortality from heat stress, changes in growth and development rates, and disease resistance. Changes in the flow regime (especially flooding and low flow events) also affect survival and behavior. Expected behavioral responses include shifts in seasonal timing of important life history events, such as the adult migration, spawn timing, fry emergence timing, and the juvenile migration. Indirect effects on salmon mortality, growth rates and movement behavior are also expected to follow from changes in the freshwater habitat structure and the invertebrate and vertebrate community, which governs food supply and predation risk (ISAB 2007, Crozier et al. 2008).

In the marine ecosystem, salmon may be affected by warmer water temperatures, increased stratification of the water column, intensity and timing changes of coastal upwelling, loss of coastal habitat due to sea level rise, ocean acidification, and changes in water quality and freshwater inputs (ISAB 2007, Mauger et al. 2015). Salmon marine migration patterns could be affected by climate-induced contraction of thermally suitable habitat. Abdul-Aziz et al. (2011) modeled changes in summer thermal ranges in the open ocean for Pacific salmon under multiple IPCC warming scenarios. For chum, pink, coho, sockeye salmon and steelhead, they predicted contractions in suitable marine habitat of 30 to 50 percent by the 2080s, with an even larger contraction (86 to 88 percent) for Chinook salmon under the medium and high emissions scenarios. Northward range shifts are a climate response expected in many marine species, including salmon (Cheung et al. 2015). However, salmon populations are strongly differentiated in the northward extent of their ocean migration, and hence would likely respond individualistically to widespread changes in sea surface temperature.

2.2.1 Status of the Species

For Pacific salmon, steelhead, and certain other species, we commonly use the four "viable salmonid population" (VSP) criteria (McElhany et al. 2000) to assess the viability of the populations that, together, 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 (McElhany et al. 2000).

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

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

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

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. See Table 5.

Table 5. Listing status, status of critical habitat designations and protective regulations, and relevant Federal Register (FR) decision notices for ESA-listed species considered in this Opinion. Listing status: 'T' means listed as threatened; 'E' means listed as endangered.

Species	Listing Status	Critical Habitat
PS Chinook salmon *(Oncorhynchus tshawytscha)*	T 6/28/05; 70 FR 37160	9/02/05; 70 FR 52630
Hood Canal Summer Run Chum *(Oncorhynchus keta)*	T 6/28/05; 70 FR 37160	9/02/05; 70 FR 52630
PS Steelhead (*Oncorhynchus mykiss*)	T 5/11/07; 72 FR 26722	2/24/16; 81 FR 9252
PS/GB Yelloweye Rockfish *(Sebastes ruberrimus)*	T 4/28/10; 75 FR 22276	2/11/15; 79 FR 68041
PS/GB Bocaccio (*Sebastes paucispinis)*	E 4/28/10; 75 FR 22276	2/11/15; 79 FR 68041
Southern Resident Killer Whale *(Orcus orcinus)*	E 11/18/2005; 70 FR 69903	11/29/06; 79 FR 69054 08/02/21; 86 FR 41668

Status of PS Chinook Salmon

The Puget Sound Chinook salmon evolutionarily significant unit (ESU) was listed as threatened on June 28, 2005 (70 FR 37160). In 2016, we completed a 5-year status review of Chinook salmon (NMFS 2017c). 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 a supplement by NMFS (2006). The recovery plan adopts ESU and population level viability criteria recommended by the Puget Sound Technical Recovery Team (PSTRT) (Ruckelshaus et al. 2002). The PSTRT's biological recovery criteria will be met when all of the following conditions are achieved:

- The viability status of all populations in the ESU is improved from current conditions, and when considered in the aggregate, persistence of the ESU is assured;
- Two to four Chinook salmon populations in each of the five biogeographical regions of the ESU (Table 6) 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 the viability criteria for all VSP parameters are sustained to provide ecological functions and preserve options for ESU recovery.

On October 4, 2019, NMFS published notice of NMFS' intent to initiate a new 5-year status review for 28 listed species of Pacific salmon and steelhead and requesting updated information from the public to inform the status review (84 FR 53117). On March 24, 2020, NMFS extended the public comment period, from the original March 27, 2020, through May 26, 2020 (85 FR 16619). The NMFS' West coast Regional Office (WCRO) is currently preparing the final status review documents. In this section, we utilize information from the NWFSC's biological viability report update for Pacific salmon and steelhead (Ford 2022) in order to provide the most recent information for our evaluation in this Opinion.

<u>Spatial Structure and Diversit</u>y. The PS 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 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 (MPG), that are based on similarities in hydrographic, biogeographic, and geologic characteristics (Table 6).

Table 6. Extant PS Chinook salmon populations in each biogeographic region and percent change between the most recent two 5-year periods (2010-2014 and 2015-2019). Five-year geometric mean of raw natural-origin spawner counts. This is the raw total spawner estimate times the fraction natural-origin estimate, if available. In parentheses, 5-year geometric mean of raw total spawner estimates (i.e., hatchery and natural) are shown. A value only in parentheses means that a total spawner estimate was available but no (or only one) estimate of natural-origin spawners was available. The geometric mean was computed as the product of estimates raised to the power 1 over the number of counts available (2 to 5). A minimum of 2 values were used to compute the geometric mean. Percent change between the most recent two 5-year periods is shown on the far right (Ford 2022).

Biogeographic Region	Population (Watershed)	2010-2014	2015-2019	Population trend (% change)
Strait of Georgia	**North Fork Nooksack River**	136 (1205)	137 (1553)	Positive 1% (29)
	South Fork Nooksack River	13 (35)	42 (106)	Positive 223% (203)
Strait of Juan de Fuca	**Elwha River**	71 (1349)	134 (2810)	Positive 89% (108)
	Dungeness River	66 (279)	114 (476)	Positive 73% (71)
Hood Canal	**Skokomish River**	136 (1485)	265 (2074)	Positive 95% (40)
	Mid Hood Canal River	80 (295)	196 (222)	Positive 145% (-25)
Whidbey Basin	Skykomish River	1698 (2462)	1736 (2806)	Positive 3% (14)
	Snoqualmie River	839 (1082)	856 (1146)	Positive 2% (6)
	North Fork Stillaguamish River	417 (996)	302 (762)	Negative 28% (-23)
	South Fork Stillaguamish River	34 (68)	37 (96)	Positive 9% (41)
	Lower Skagit River	1416 (1541)	2130 (2640)	Positive 50% (71)
	Upper Sauk River	854 (880)	1318 (1330)	Positive 54% (51)
	Lower Sauk River	376 (416)	635 (649)	Positive 69% (56)
	Suiattle River	376 (378)	640 (657)	Positive 70% (74)
	Upper Cascade River	298 (317)	185 (223)	Negative 38% (-30)
Central/South Puget Sound Basin	North Lake Washington/ Sammamish River	82 (1289)	126 (879)	Positive 54% (-32)
	Green/Duwamish River	785 (2109)	1822 (6373)	Positive 132% (202)
	Puyallup River	450 (1134)	577 (1942)	Positive 28% (71)
	White River	652 (2161)	895 (6244)	Positive 37% (189)
	Cedar River	699 (914)	889 (1253)	Positive 27% (37)
	Nisqually River	481 (1823)	766 (1841)	Positive 59% (1)

NOTE: NMFS has determined that the bolded populations in Table 6, in particular, are essential to recovery of the Puget Sound Chinook salmon ESU. In addition, at least one other population within the Whidbey Basin and Central/South Puget Sound Basin regions would need to be viable for recovery of the ESU. The PSTRT noted that the Nisqually watershed is in comparatively good condition, and thus the certainty that the population could be recovered is among the highest in the Central/South Region. NMFS concluded in its supplement to the Puget Sound Salmon Recovery Plan that protecting the existing habitat and working toward a viable population in the Nisqually watershed would help to buffer the entire region against further risk (NMFS 2006b).

Since 1999, most PS Chinook salmon populations have mean natural-origin spawner escapement levels well below levels identified as required for recovery to low extinction risk. Long-term, natural-origin mean escapements for eight populations are at or below their critical thresholds.[37] Both populations in three of the five biogeographical regions are below or near their critical threshold: Georgia Strait, Hood Canal and Strait of Juan de Fuca. When hatchery spawners are included, aggregate average escapement is over 1,000 for one of the two populations in each of these three regions, reducing the demographic risk to the populations in these regions. Additionally, hatchery spawners help two of the remaining three of these populations achieve total spawner abundances above their critical threshold, reducing demographic risk. Nine populations are above their rebuilding thresholds,[38] seven of them in the Whidbey/Main Basin Region. In 2018 NMFS and the NWFSC updated the rebuilding thresholds for several key Puget Sound populations. These thresholds represent the Maximum Sustained Yield estimate of spawners based on available habitat. The new spawner-recruit analyses for several populations indicated a significant reduction in the number of spawners that can be supported by the available habitat when compared to analyses conducted 10 to 15 years ago. This may be due to further habitat degradation or improved productivity assessment or, more likely, a combination of the two. For example, the updated rebuilding escapement threshold for the Green River is 1,700 spawners compared to the previous rebuilding escapement threshold of 5,523 spawners.[39] So, although several populations are above the updated rebuilding thresholds, indicating that escapement is sufficient for the available habitat in many cases, the overall abundance has declined.

The ESU also includes Chinook salmon from certain artificial propagation programs. Artificial propagation (hatchery) programs (26) were added to the listed Chinook salmon ESU in 2005, as part of the final listing determinations for 16 ESUs of West Coast Salmon and Final 4(d)

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[37] After considering uncertainty, the critical threshold is defined as a point below which: (1) depensatory processes are likely to reduce the population below replacement; (2) the population is at risk from inbreeding depression or fixation of deleterious mutations; or (3) productivity variation due to demographic stochasticity becomes a substantial source of risk (NMFS 2000).

[38] The rebuilding threshold is defined as the escapement that will achieve Maximum Sustainable Yield (MSY) under current environmental and habitat conditions (NMFS 2000), and is based on an updated spawner-recruit assessment in the Puget Sound Chinook Harvest Management Plan, December 1, 2018. Thresholds were based on population-specific data, where available.

[39] The historic Green River escapement goal was established in 1977 as the average of estimated natural spawning escapements from 1965-1974. This goal does not reflect the lower productivity associated with the current condition of habitat. Reference the source for the historical objective from the Green River Management Unit Profile (PSIT and WDFW 2017).

Protective Regulations for Threatened Salmonid ESUs (70 FR 37160). In October of 2016, NMFS proposed revisions to the hatchery programs included as part of some Pacific salmon ESUs and steelhead DPSs listed under the ESA (81 FR 72759). NMFS issued its final rule in December of 2020 (85 FR 81822). This final rule includes 25 hatchery programs as part of the listed Puget Sound Chinook salmon ESU: Kendall Creek Hatchery Program; Marblemount Hatchery Program (spring-run); Marblemount Hatchery Program (summer-run); Brenner Creek Hatchery Program (fall-run); Harvey Creek Hatchery Program (summer-run); Whitehorse Springs Hatchery Program (summer-run); Wallace River Hatchery Program (yearlings and subyearlings); Issaquah Creek Hatchery Program; White River Hatchery Program; White River Acclimation Pond Program; Voights Creek Hatchery Program; Clarks Creek Hatchery Program; Clear Creek Hatchery Program; Kalama Creek Hatchery Program; George Adams Hatchery Program; Hamma Hamma Hatchery Program; Dungeness/Hurd Creek Hatchery Program; Elwha Channel Hatchery Program; Skookum Creek Hatchery Spring-run Program; Bernie Kai-Kai Gobin (Tulalip) Hatchery-Cascade Program; North Fork Skokomish River Spring-run Program; Soos Creek Hatchery Program (subyearlings and yearlings); Fish Restoration Facility Program; Bernie Kai-Kai Gobin (Tulalip) Hatchery-Skykomish Program; and Hupp Springs Hatchery-Adult Returns to Minter Creek Program.

Three of the five regions (Strait of Juan de Fuca, Georgia Basin, and Hood Canal) contain only two populations, both of which must be recovered to viability to recover the ESU (NMFS 2006b). Under the Puget Sound Salmon Recovery Plan, the Suiattle and one each of the early, moderately early, and late run-timing populations in the Whidbey Basin Region, as well as the White and Nisqually (or other late-timed) populations in the Central/South Sound Region must also achieve viability (NMFS 2006b).

The Technical Recovery Team (TRT) did not define the relative roles of the remaining populations in the Whidbey and Central/South Sound Basins for ESU viability. Therefore, NMFS developed additional guidance which considers distinctions in genetic legacy and watershed condition, among other factors, in assessing the risks to survival and recovery of the listed species by the proposed action across all populations within the PS Chinook salmon ESU. In doing so, it is important to consider whether the genetic legacy of the population is intact or if it is no longer distinct within the ESU. Populations are defined by their relative isolation from each other and by the unique genetic characteristics that evolve, as a result of that isolation, and adaption to their specific habitats. If these populations still retain their historic genetic legacy, then the appropriate course, to ensure their survival and recovery, is to preserve that genetic legacy and rebuild those populations. Preserving that legacy requires both a sense of urgency and the actions necessary and appropriate to preserve the legacy that remains. However, if the genetic legacy is gone, then the appropriate course is to recover the populations using the individuals that best approximate the genetic legacy of the original population, reduce the effects of the factors that have limited their production, and provide the opportunity for them to readapt to the existing conditions.

In keeping with this approach, NMFS further classified PS Chinook salmon populations into three tiers based on a systematic framework that considers the population's life history and production and watershed characteristics (NMFS 2010b) (Figure 1). This framework, termed the Population Recovery Approach, carries forward the biological viability and delisting criteria described in the Supplement to the Puget Sound Salmon Recovery Plan (Ruckelshaus et al. 2002; NMFS 2006b). The assigned tier indicates the relative role of each of the 22 populations comprising the ESU to the viability of the ESU and its recovery. Tier 1 populations are most important for preservation, restoration, and ESU recovery. Tier 2 populations play a less important role in recovery of the ESU. Tier 3 populations play the least important role. When we analyze proposed actions, we evaluate impacts at the individual population scale for their effects on the viability of the ESU. We expect that impacts to Tier 1 populations would be more likely to affect the viability of the ESU, as a whole, than similar impacts to Tier 2 or 3 populations, because of the relatively greater importance of Tier 1 populations to overall ESU viability and recovery. NMFS has incorporated this and similar approaches in previous ESA section 4(d) determinations and Opinions on Puget Sound salmon fisheries and regional recovery planning (NMFS 2005b; 2005d; 2008f; 2010a; 2011a; 2013b; 2014b; 2015c; 2016f; 2017b; 2018c; 2019b)

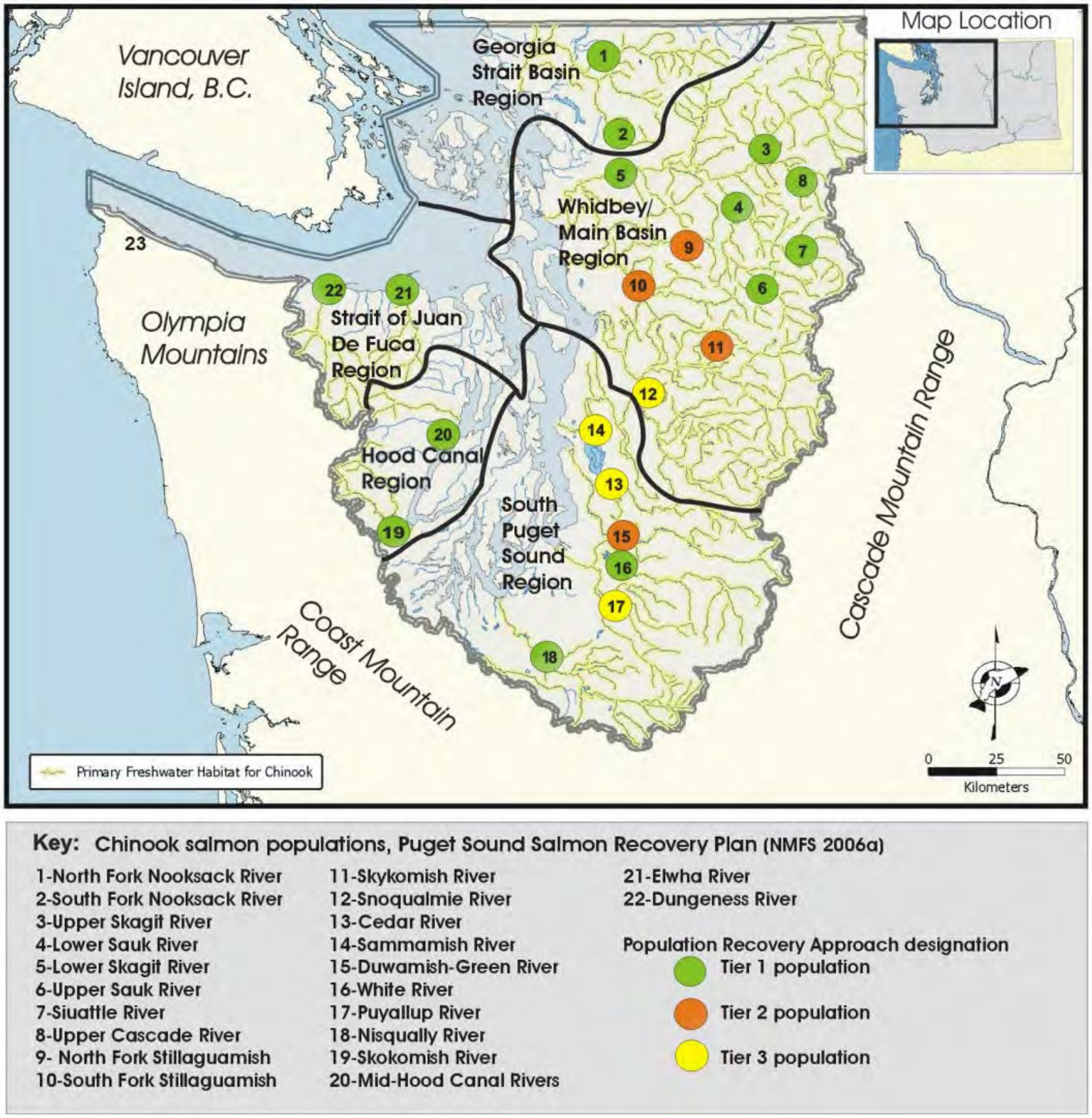

Figure 1. Puget Sound Chinook salmon populations.

Measures of spatial structure and diversity can give some indication of the resilience of a population to sustain itself. Spatial structure can be measured in various ways, but here we assess the proportion of natural-origin spawners (wild fish) vs. hatchery-origin spawners on the spawning grounds (Ford 2022).

Over the long-term trend (since 1990), there is a general declining trend in the proportion of natural-origin spawners across the ESU (Table 8). While there are several populations that have maintained high levels of natural-origin spawner proportions, mostly in the Skagit and Snohomish basins, many others have continued the trend of high proportions of hatchery-origin spawners in the most recent available period (Table 8). It should be noted that the pre-2005-2009 estimates of mean natural-origin fractions occurred prior to the widespread adoption of mass marking of hatchery produced fish. Estimates of hatchery and natural-origin proportions of fish since the implementation of mass marking are considered more robust. Several of these populations have long-standing or more recent conservation hatchery programs associated with them—North Fork (NF) and South Fork (SF) Nooksack, NF and SF Stillaguamish, White River, Mid-Hood Canal, Dungeness, and the Elwha. These conservation programs are in place to maintain or increase the overall abundance of these populations, helping to conserve the diversity and increase the spatial distribution of these populations in the absence of properly functioning habitat. With the exception of the Mid-Hood Canal program, these conservation hatchery programs culture the extant, native Chinook salmon stock in these basins. With the exception of the NF and SF Stillaguamish, the remainder of the populations included in these conservation programs are identified in NMFS (2006b) as essential for the recovery of the Puget Sound Chinook salmon ESU (Table 7).

In addition, spatial structure, or geographic distribution, of the White, Skagit, Elwha,[40] and Skokomish populations has been substantially reduced or impeded by the loss of access to the upper portions of those tributary basins due to flood control activities and hydropower development. Habitat conditions conducive to salmon survival in most other watersheds have been reduced significantly by the effects of land use, including urbanization, forestry, agriculture, and development (NMFS 2005a; SSPS 2005; NMFS 2008c; 2008d; 2008b). It is likely that genetic and life history diversity has been significantly adversely affected by this habitat loss.

[40] Removal of the two Elwha River dams and restoration of the natural habitat in the watershed began in 2011.

Table 7. Five-year mean of fraction of natural-origin spawners[41] (sum of all estimates divided by the number of estimates) (Ford 2022).

Population	1995-1999	2000-2004	2005-2009	2010-2014	2015-2019
NF Nooksack R. spring	0.28	0.11	0.19	0.14	0.13
SF Nooksack R. spring	0.26	0.55	0.57	0.42	0.45
Low. Skagit R. fall	0.94	0.91	0.86	0.92	0.84
Up. Skagit R. summer	0.91	0.87	0.84	0.95	0.91
Cascade R. spring	0.98	0.92	0.89	0.94	0.86
Low. Sauk R. summer	0.94	0.97	0.95	0.91	0.98
Up. Sauk R. spring	0.99	1.00	0.98	0.97	0.99
Suiattle R. spring	0.99	0.97	0.99	0.99	0.97
NF Stillaguamish R. summer/fall	0.59	0.70	0.40	0.43	0.45
SF Stillaguamish R. summer/fall	0.59	0.70	0.40	0.54	0.46
Skykomish R. summer	0.49	0.52	0.76	0.69	0.62
Snoqualmie R. fall	0.81	0.89	0.81	0.78	0.75
Sammamish R. fall	0.29	0.36	0.16	0.07	0.16
Cedar R. fall	0.61	0.59	0.82	0.78	0.71
Green R. fall	0.55	0.47	0.43	0.39	0.30
White R. spring	0.54	0.79	0.43	0.32	0.15
Puyallup R. fall	0.88	0.79	0.52	0.41	0.32
Nisqually R. fall	0.80	0.61	0.30	0.30	0.47
Skokomish R. fall	0.40	0.46	0.45	0.10	0.16
Mid-Hood Canal fall	0.76	0.79	0.61	0.33	0.89
Dungeness R. summer	1.00	0.32	0.43	0.25	0.25
Elwha R. fall	0.41	0.53	0.35	0.06	0.05

Abundance and Productivity. The abundance of the PS Chinook salmon over time shows that individual populations have varied with increasing or decreasing abundance. Generally, many populations experienced increases in total abundance during the years 2000-2008, and more recently in 2015-2017, but general declines during 2009-2014, and a downturn again in the two most recent years available for the current status review, 2017-2018 (Figure 2). Abundance across the Puget Sound ESU has generally increased since the last status review, with only 2 of the 22 populations (Cascade and North Fork and South Fork Stillaguamish) showing a negative percent change in the 5-year geometric mean natural- origin spawner abundances since the prior status review. However, 15 of 20 populations with positive percent change in the 5-year geometric mean natural-origin spawner abundances since the prior status review have relatively low population abundances of <1000 fish, so some of these increases represent small changes in total abundance (Ford 2022). Also, given lack of high confidence in survey techniques, particularly with small populations, there is substantial uncertainty in quantifying fish and detecting trends in small populations (Gallagher et al. 2010).

[41] Estimates of hatchery and natural-origin spawning abundances, prior to the 2005-2009 period are based on pre-mass marking of hatchery-origin fish and, as such, may not be directly comparable to the 2005-2009 forward estimates.

Trends in abundance over longer time periods are generally slightly negative. Fifteen-year trends in log natural-origin spawner abundance were computed over two time periods (1990-2005 and 2004- 2019) for each Puget Sound Chinook salmon population. Trends were negative in the latter period for 16 of the 22 populations and for four of the 22 populations (SF Nooksack, SF Stillaguamish, Green and Puyallup) in the earlier period. Thus, there is a general decline in natural-origin spawner abundance across all MPGs in the recent fifteen years. Upper Sauk and Suiattle (Whidbey Basin MPG), Nisqually (Central/South MPG) and Mid-Hood Canal (Hood Canal MPG) are the only populations with positive trends, though Mid-Hood Canal has an extremely low population size. Further, no change in trend between the two time periods was detected in SF Nooksack (Strait of Georgia MPG), Green and Nisqually (Central/South MPG). The average trend across the ESU for the 1990-2005 15-year time period was 0.03. The average trend across the ESU for the later 15-year time period (2004-2019) was -0.02. The previous status review in 2015 (NWFSC 2015) concluded there were widespread negative trends for the total ESU despite that escapements and trends for individual populations were variable. The addition of the data to 2018 now also shows even more substantially either flat or negative trends for the entire ESU in natural-origin Chinook salmon spawner population abundances (Ford 2022).

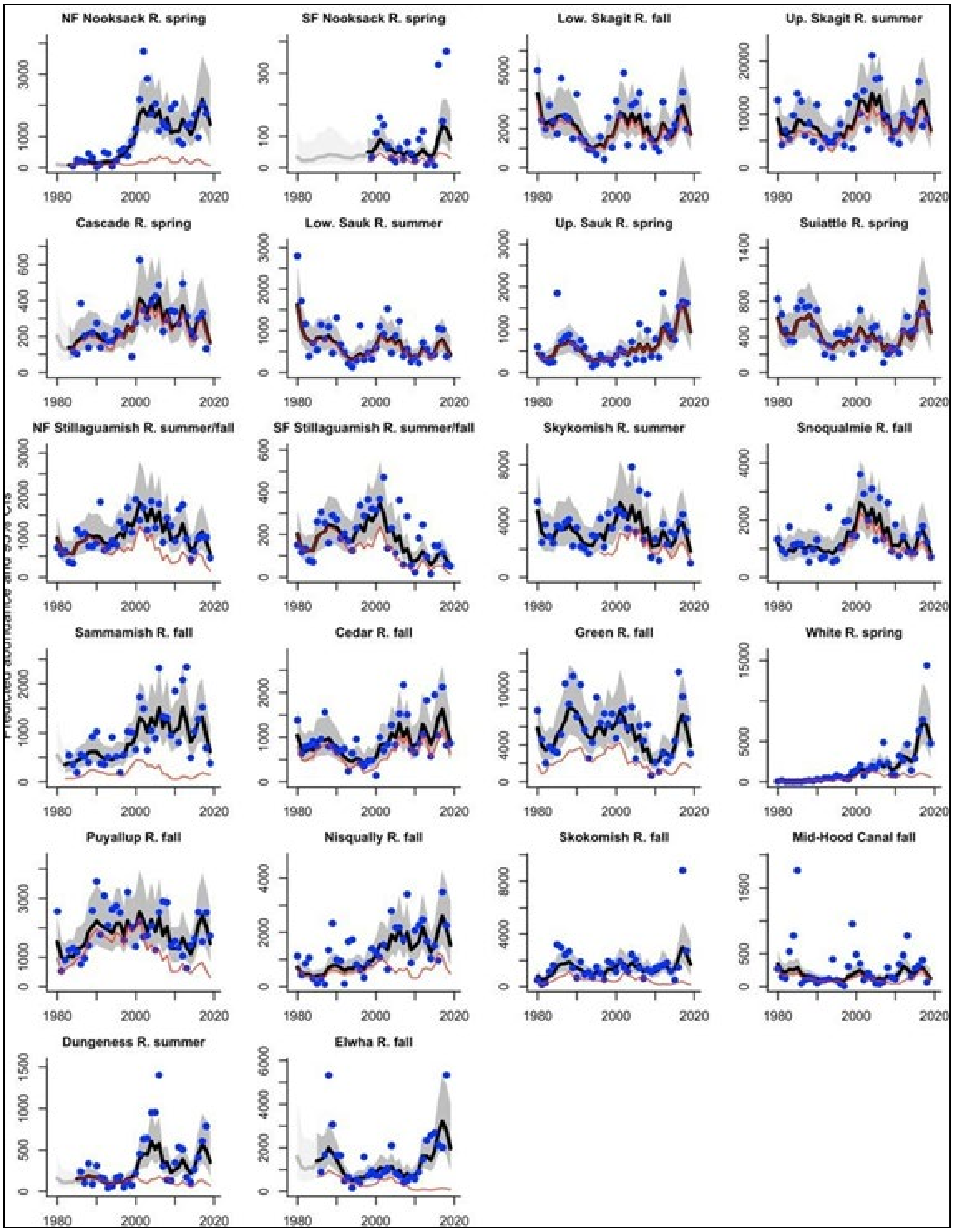

Figure 2. Smoothed trend in estimated total (thick black line, with 95 percent confidence internal in gray) and natural (thin red line) PS Chinook salmon population spawning abundance. In portions of a time series where a population has no annual estimate but smoothed spawning abundance is estimated from correlations with other populations the smoothed estimate is shown in light gray. Points show the annual raw spawning abundance estimates. For some trends the smoothed estimate may be influenced by earlier data points not included in the plot (Ford 2022).

Across the Puget Sound ESU, 10 of 22 Puget Sound populations show natural productivity below replacement in nearly all years since the mid-1980's (Figure 3). These include the North and South Forks Nooksack in the Strait of Georgia MPG, North and South Forks Stillaguamish and Skykomish in Whidbey Basin MPG, Sammamish, Green and Puyallup in the Central/South MPG, the Skokomish in the Hood Canal MPG, and Elwha in the Strait of Juan de Fuca MPG. Productivity in the Whidbey Basin MPG populations was above zero the mid-late 1990's, with the exception of Skykomish and North and South Forks Stillaguamish populations. White River population in the Central/South MPG was above replacement from the early 1980's to 2001, but has dropped in productivity consistently since the late 1980's. In recent years, only 5 populations have had productivities above zero. These are Lower Skagit, Upper Skagit, Lower Sauk, Upper Sauk, and Suiattle, all Skagit River populations in the Whidbey Basin MPG. This is consistent with, and continues the decline reported in the latest NWFSC biological viability update (Ford 2022).

All Puget Sound Chinook salmon populations continue to remain well below recovery levels (Ford 2022). Most populations also remain consistently below the spawner-recruit levels identified by the TRT as necessary for recovery. Across the ESU, most native-origin populations have slightly increased in abundance since the last status review in 2016, but have small negative trends over the past 15 years (Figure 4). Productivity remains low in most populations. Hatchery-origin spawners are present in high fractions in most populations outside the Skagit watershed, and in many watersheds the fraction of spawner abundances that are natural-origin have declined over time. Habitat protection, restoration and rebuilding programs in all watersheds have improved stream and estuary conditions despite record numbers of humans moving into the Puget Sound region in the past two decades. Bi-annual four-year work plans document the many completed habitat actions that were initially identified in the Puget Sound Chinook salmon recovery plan. However, the expected benefits from restoration actions is likely to take years or decades to produce significant improvement in natural population viability parameters (see Roni et al. 2010).

Development of a monitoring and adaptive management program was required by NMFS in the 2007 Supplement to the Shared Strategy Recovery Plan (NMFS 2006b), and since the last review the Puget Sound Partnership has completed this, but this program is still not fully functional for providing an assessment of watershed habitat restoration/recovery programs, nor does it fully integrate the essentially discrete habitat, harvest and hatchery programs. A recent white paper produced by the Salmon Science Advisory Group, of the Puget Sound Partnership concludes there has been "a general inability of monitoring to link restoration, changes in habitat conditions, and fish response at large-scales" (PSP 2021). A number of watershed groups are in the process of updating their Recovery Plan Chapters and this includes prioritizing and updating recovery strategies and actions, as well as assessing prior accomplishments. Overall, recent information on PS Chinook salmon abundance and productivity since the 2016 status review indicates a slight increase in abundance but does not indicate a change in biological risk to the ESU despite moderate inter-annual variability among populations and a general decline in abundance over the last 15 years (Ford 2022).

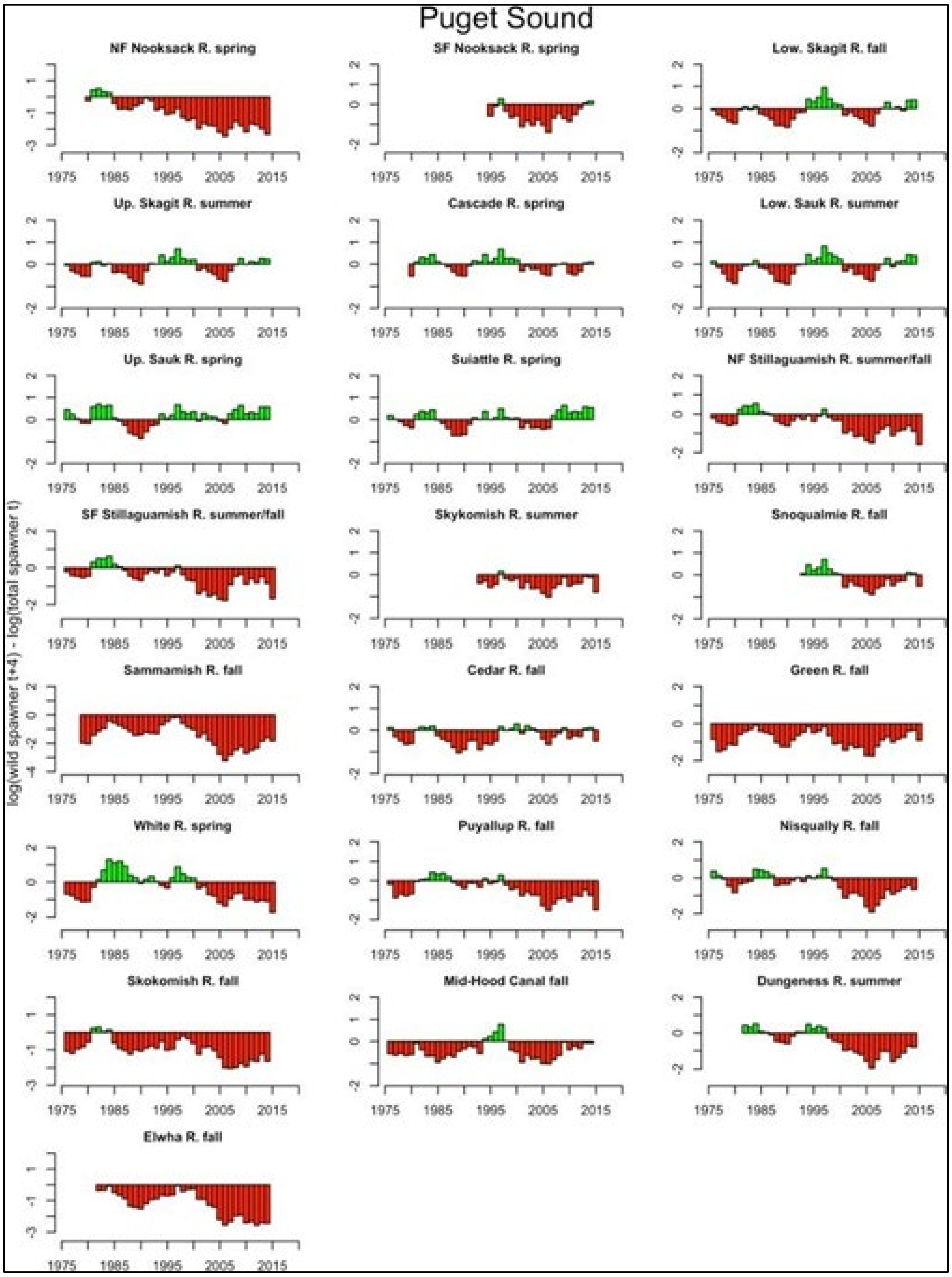

Figure 3. Trends in population productivity, estimated as the log of the smoothed natural-origin spawning abundance in year t – smoothed natural-origin spawning abundance in year (t – 4) (Ford 2022).

Limiting Factors. Limiting factors for this species 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
- Altered flow regime

PS Chinook Salmon Recovery Plan. Nearshore areas serve as the nursery for juvenile PS Chinook salmon. Riparian vegetation, shade and insect production, and forage fish eggs along marine shorelines and river deltas help to provide food, cover and thermoregulation in shallow water habitats. Forage fish spawn in large aggregations along shorelines with suitable habitat, which produce prey for juvenile PS Chinook salmon. Juvenile salmon commonly occupy "pocket estuaries" where freshwater inputs provide salinity gradients that make adjusting to the marine environment less physiologically demanding. Pocket estuaries also provide refugia from predators. As the juvenile salmon grow and adjust, they move out to more exposed shorelines such as eelgrass, kelp beds and rocky shorelines where they continue to grow and migrate into the ocean environment. Productive shoreline habitats of Puget Sound are necessary for the recovery of Puget Sound salmon (SSPS 2007).

The Puget Sound Recovery Plan (Volumes 1 and 2) includes specific recovery actions for each of the 22 extant populations of PS Chinook salmon. General protection and restoration actions summarized from the plan include:

- Aggressively protect functioning drift cells and feeder bluffs that support eelgrass bands and depositional features;
- Counties should pass strong regulations and policies limiting increased armoring of these shorelines and offering incentives for protection;
- Aggressively protect areas, especially shallow water/low gradient habitats and pocket estuaries, within 5 miles of river deltas;
- Protect the forage fish spawning areas;
- Conduct limited beach nourishment on a periodic basis to mimic the natural sediment transport processes in select sections where corridor functions may be impaired by extensive armoring;
- Maintain the functioning of shallow, fine substrate features in and near 11 natal estuaries for Chinook salmon (to support rearing of fry);
- Maintain migratory corridors along the shores of Puget Sound;
- Maintain the production of food resources for salmon;
- Maintain functioning nearshore ecosystem processes (i.e., sediment delivery and transport; tidal circulation) that create and support the above habitat features and functions;
- Increase the function and capacity of nearshore and marine habitats to support key needs of salmon;
- Protect and restore shallow, low velocity, fine substrate habitats along marine shorelines, including eelgrass beds and pocket estuaries, especially adjacent to major river deltas;
- Protect and restore riparian areas;
- Protect and restore estuarine habitats of major river mouths;

- Protect and restore spawning areas and critical rearing and migration habitats for forage fish;
- Protect and restore drift cell processes (including sediment supply, e.g., from feeder bluffs, transport, and deposition) that create and maintain nearshore habitat features such as spits, lagoons, bays, beaches.

Development of shoreline and estuary areas of Puget Sound is expected to continue to adversely impact the quality of marine habitat for PS Chinook salmon. Projected changes in nearshore and estuary development based on documented rates of developed land cover change in Bartz et al. (2015) show that between 2008 and 2060, an additional 14.7 hectares of development of shoreline areas and 204 hectares of estuary development can be expected.[42]

Status of Hood Canal Summer-run Chum Salmon

The Hood Canal summer-run (HCSR) chum salmon was listed as threatened on June 28, 2005 (70 FR 37160). In 2016, NMFS completed a 5-year status review of HCSR chum salmon (NMFS 2017c) and in 2022, the NWFSC released a biological viability update for Pacific salmon and steelhead (Ford 2022). We adopted a recovery plan for HCSR chum salmon in May of 2007. The recovery plan consists of two documents: the Hood Canal and Eastern Strait of Juan de Fuca Summer Chum Salmon Recovery Plan (Hood Canal Coordinating Council 2005) and a supplemental plan by NMFS (2007a). The recovery plan adopts ESU and population level viability criteria recommended by the PSTRT (Sands et al. 2009). The PSTRT's biological recovery criteria will be met when the following conditions are achieved:

- Spatial Structure: (1) Spawning aggregations are distributed across the historical range of the population. (2) Most spawning aggregations are within 20 km of adjacent aggregations. (3) Major spawning aggregations are distributed across the historical range of the population and are not more than approximately 40 km apart. Further, a viable population has spawning, rearing, and migratory habitats that function in a manner that is consistent with population persistence
- Diversity: Depending on the geographic extent and ecological context of the population, a viable population includes one or more persistent spawning aggregations from each of the two to four major ecological diversity groups historically present within the two populations (see also McElhany et al. 2000).
- Abundance and Productivity: Achievement of minimum abundance levels associated with persistence of HCSR chum salmon ESU populations that are based on two assumptions about productivity and environmental response (Table 8).

Despite substantive gains towards meeting viability criteria in the Hood Canal and Strait of Juan de Fuca summer chum salmon populations, the ESU still does not meet all of the recovery criteria for population viability at this time (NWFSC 2015, NMFS 2017c).

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[42] Memorandum from Tim Beechie, Northwest Fisheries Science Center, to Kim Kratz, et al. NMFS, regarding projected developed land cover change in Puget Sound nearshore and estuary zones. (June 23, 2020).

Table 8. Hood Canal summer-run chum salmon ESU abundance and productivity recovery goals (Sands et al. 2009).

Population	Low Productivity Planning Target for Abundance (productivity in parentheses)	High Productivity Planning Target for Abundance (productivity in parentheses)
Strait of Juan de Fuca	12,500 (1.0)	4,500 (5.0)
Hood Canal	24,700 (1.0)	18,300 (5.0)

Spatial Structure and Diversity. The ESU includes all naturally spawning populations of summer-run chum salmon in Hood Canal tributaries as well as populations in Olympic Peninsula rivers between Hood Canal and Dungeness Bay, Washington, as well as several artificial propagation programs. The Puget Sound Technical Recovery Team (PSTRT) identified two independent populations for the HCSR chum salmon, one which includes the spawning aggregations from rivers and creeks draining into the Strait of Juan de Fuca, and one which includes spawning aggregations within Hood Canal proper (Sands et al. 2009).

Spatial structure and diversity measures for the HCSR chum salmon recovery program have included the reintroduction and sustaining of natural-origin spawning in multiple small streams where summer chum salmon spawning aggregates had been extirpated. Supplementation programs have been very successful in both increasing natural spawning abundance in 6 of 8 extant streams (Salmon, Big Quilcene, Lilliwaup, Hamma Hamma, Jimmycomelately, and Union) and increasing spatial structure due to reintroducing spawning aggregations to three streams (Big Beef, Tahuya, and Chimacum). Spawning aggregations are present and persistent within five of the six major ecological diversity groups identified by the PSTRT (Table 9). As supplementation program goals have been met in most locations, they have been terminated except in Lilliwaup/Tahuya, where supplementation is ongoing (NWFSC 2015). Spatial structure and diversity viability parameters for each population have increased and nearly meet the viability criteria.

Table 9 Seven ecological diversity groups as proposed by the PSTRT for the HCSR chum salmon ESU by geographic region and associated spawning aggregation.

Geographic Region (population)	Proposed Ecological Diversity Groups	Spawning aggregations: Extant* and extinct**
Eastern Strait of Juan de Fuca	Dungeness	Dungeness R (unknown status)
	Sequim-Admiralty	Jimmycomelately Cr* Salmon Cr* Snow Cr* Chimacum Cr**
Hood Canal	Toandos	Unknown
	Quilcene	Big Quilcene R* Little Quilcene R*
	Mid-West Hood Canal	Dosewallips R* Duckabush R*
	West Kitsap	Big Beef Cr** Seabeck Cr** Stavis Cr** Anderson Cr** Dewatto R** Tahuya R** Mission Cr** Union R*
	Lower West Hood Canal	Hamma Hamma R* Lilliwaup Cr* Skokomish R*

Abundance and Productivity. Smoothed trends in estimated total and natural population spawning abundances for both Hood Canal and Strait of Juan de Fuca populations have generally increased over the 1980 to 2014 time period. The Hood Canal population has had a 25 percent increase in abundance of natural-origin spawners in the most recent 5-year time period over the 2005-2009 time period. The Strait of Juan de Fuca has had a 53 percent increase in abundance of natural-origin spawners in the most recent 5-year time period.

Trends in population productivity, estimated as the log of the smoothed natural spawning abundance in year t minus the smoothed natural spawning abundance in year (t-4), have increased over the past five years, and were above replacement rates in 2012 and 2013. However, productivity rates have varied above and below replacement rates over the entire time period up to 2014. The Point No Point Treaty Tribes and the Washington State Department of Fish and Wildlife (PNPTT and WDFW 2014) provide a detailed analysis of productivity for the ESU, each population, and by individual spawning aggregation, and report that 3 of the 11 stocks exceeded the co-manager's interim productivity goal of an average of 1.6 Recruit/Spawner over 8 years. They also report that natural-origin Recruit/Spawner rates have been highly variable in recent brood years, particularly in the Strait of Juan de Fuca population. Only one spawning aggregation (Chimacum) meets the co-manager's interim recovery goal of 1.2 recruits per spawner in 6 of the most recent 8 years. Productivity of individual spawning aggregates shows only two of eight aggregates have viable performance. (NWFSC 2015, NMFS 2017).

Limiting factors. Limiting factors for this species include (HCCC 2005):

- Reduced floodplain connectivity and function

- Poor riparian condition
- Loss of channel complexity (reduced large wood and channel condition, loss of side channels, channel instability)
- Sediment accumulation
- Altered flows and water quality

Mantua et al. (2010) suggested that the unique life history of HCSR chum salmon makes this ESU especially vulnerable to the climate change impacts because they spawn in small shallow streams in late summer, eggs incubate in the fall and early winter, and fry migrate to sea in late winter. Sensitivity during the adult freshwater stage and the early life history was ranked moderate. Predicted climate change effects for the low-elevation Hood Canal streams historically used by summer chum salmon include multiple negative impacts stemming from warmer water temperatures and reduced streamflow in summer, and the potential for increased redd-scouring from peak flow magnitudes in fall and winter. Exposure for stream temperature and summer water deficit were both ranked high, largely due to effects on returning adults and hatched fry. Likewise, sensitivity to cumulative life-cycle effects was ranked high.

Hood Canal Summer-run Chum Salmon Recovery Plan. The 2005 recovery plan for Hood Canal summer-run chum salmon currently guides habitat protection and restoration activities for chum salmon recovery (HCCC 2005; NMFS 2007a). Human-caused degradation of HCSR chum salmon habitat has diminished the natural resiliency of Hood Canal/Strait of Juan de Fuca river deltas and estuarine habitats (HCCC 2005). Despite some improvement in habitat protection and restoration actions and mechanisms, concerns remain that given the pressures of population growth, existing land use management measures through local governments (i.e., shoreline management plans, critical area ordinances, and comprehensive plans) may be compromised or not enforced (SSPS 2007). "The widespread loss of estuary and lower floodplain habitat was noted by the BRT as a continuing threat to ESU spatial structure and connectivity" (NMFS 2003; 69 FR 33134).

The HCSR chum salmon recovery plan includes specific recovery actions for each stream (HCCC 2005). General protection and restoration actions summarized from those streams include:

- Incorporate channel migration zones within the protected areas of the Shoreline Master Plans of local governments.
- Acquire high priority spawning habitat
- Set back or remove levees in the lower rivers and in river deltas
- Restore upstream ecosystem processes to facilitate delivery of natural sediment and large wood features to lower river habitats
- Remove armoring along the Hood Canal shoreline, including private bulkheads, roadways, and railroad grades
- Restore large wood to river deltas and estuarine habitats
- Restore salt marsh habitats

Status of PS Steelhead

The PS steelhead DPS was listed as a threatened species under the ESA on May 11, 2007 (72 FR 26722). Subsequent status assessments of the DPS after the ESA-listing decision have found that the status of PS steelhead regarding risk of extinction has not changed substantially (Ford et al. 2011a; NMFS 2016a; Ford 2022) (81 FR 33468, May 26, 2016). As mentioned above in the PS Chinook salmon status review section, on October 4, 2019 NMFS published a Federal Register notice (84 FR 53117), announcing NMFS' intent to initiate a new 5-year status review for 28 listed species of Pacific salmon and steelhead and requesting updated information from the public to inform the most recent five-year status review. On March 24, 2020, NMFS extended the public comment period, from the original March 27, 2020, through May 26, 2020 (85 FR 16619). The NWFSC and the NMFS' WCR are currently preparing the final five-year status review documents, with anticipated release in 2022. In this Opinion, where possible, the 2015 status review information is supplemented with information and other population specific data available considered during the drafting of the most recent five-year status review for PS Chinook salmon and steelhead.

At the time of listing the Puget Sound steelhead Biological Review Team (BRT) considered the major risk factors associated with spatial structure and diversity of PS steelhead to be: (1) the low abundance of several summer run populations; (2) the sharply diminishing abundance of some winter steelhead populations, especially in south Puget Sound, Hood Canal, and the Strait of Juan de Fuca; and (3) continued releases of out-of-ESU hatchery fish from Skamania-derived summer run and Chambers Creek-derived winter run stocks (Hard et al. 2007; Hard et al. 2015). Loss of diversity and spatial structure were judged to be "moderate" risk factors (Hard et al. 2007). In 2011 the BRT identified degradation and fragmentation of freshwater habitat, with consequential effects on connectivity, as the primary limiting factors and threats facing the PS steelhead DPS (Ford et al. 2011a). The BRT also determined that most of the steelhead populations within the DPS continued to show downward trends in estimated abundance, with a few sharp declines (Ford et al. 2011a). The 2015 status review concurred that harvest and hatchery production of steelhead in Puget Sound were at low levels and not likely to increase substantially in the foreseeable future, thus these risks have been reduced since the time of listing. However, unfavorable environmental trends previously identified (Ford et al. 2011a) were expected to continue (Hard et al. 2015).

As part of the recovery planning process, NMFS convened The Puget Sound Steelhead Technical Recovery Team (PSSTRT) in 2011 to identify historic populations and develop viability criteria for the recovery plan. The PSSTRT delineated populations and completed a set of population viability analyses (PVAs) for these Demographically Independent Populations (DIPs) and MPGs within the DPS that are summarized in the final viability criteria reports (Puget Sound steelhead Technical Recovery Team 2011; PSSTRT 2013; NWFSC 2015). This framework and associated analysis provided a technical foundation for the recovery criteria and recovery actions identified in the subsequent Puget Sound Steelhead Recovery Plan (NMFS 2019g) at the watershed scale, and higher across the PS steelhead DPS.

The populations within the PS steelhead DPS are aggregated into three extant MPGs containing a total of 32 DIPs based on genetic, environmental, and life history characteristics. Populations include summer steelhead only, winter steelhead only, or a combination of summer and winter run timing (e.g., winter run, summer run or summer/winter run). Figure 4 illustrates the DPS, MPGs, and DIPs for PS steelhead.

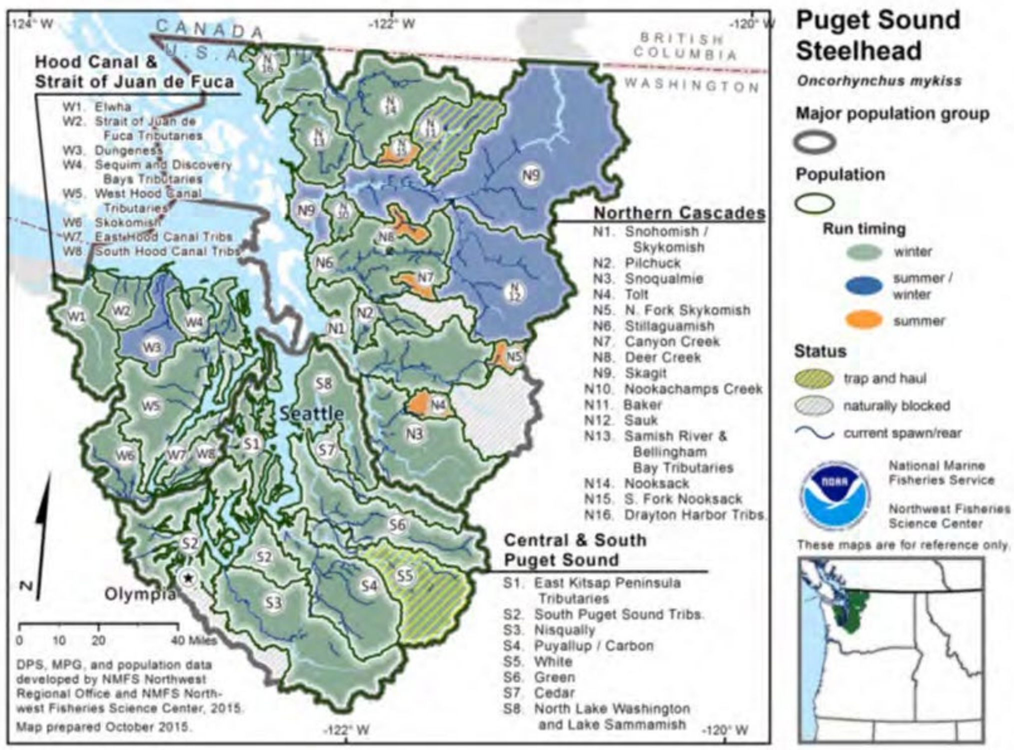

Figure 4. The PS steelhead DPS showing MPGs and DIPs. The steelhead MPGs include the Northern Cascades, Central & Sound Puget Sound, and the Hood Canal & Strait of Juan de Fuca.

NMFS adopted a recovery plan for PS steelhead on December 20, 2019 (https://www.fisheries.noaa.gov/resource/document/esa-recovery-plan-puget-sound-steelhead-distinct-population-segment-oncorhynchus). The Puget Sound steelhead Recovery Plan (Plan) (NMFS 2019g) provides guidance to recover the species to the point that it can be naturally self-sustaining over the long term. To achieve full recovery, steelhead populations in Puget Sound need to be robust enough to withstand natural environmental variation and some catastrophic events, and they should be resilient enough to support harvest and habitat loss due to human population growth. The Plan aims to improve steelhead viability by addressing the pressures that contribute to the current condition: habitat loss/degradation, water withdrawals, declining water quality, fish passage barriers, dam operations, harvest, hatcheries, climate change effects, and reduced early marine survival. NMFS is using the recovery plan to organize and coordinate recovery of the species in partnership with state, local, tribal, and federal resource managers, and the many watershed restoration partners in the Puget Sound. Consultations, including this one, will incorporate information from the Plan (NMFS 2019g).

In the Plan, NMFS and the PSSTRT modified the 2013 and 2015 PSSTRT viability criteria to produce the viability criteria for PS steelhead, as described below:

- All three MPGs (North Cascade, Central-South Puget Sound, and Hood Canal-Strait of Juan de Fuca) (Figure 5) must be viable (Hard et al. 2015). The three MPGs differ substantially in key biological and habitat characteristics that contribute in distinct ways to the overall viability, diversity, and spatial structure of the DPS.
- There must be sufficient data available for NMFS to determine that each MPG is viable.

The Plan (NMFS 2019g) also established MPG-level viability criteria. The following are specific criteria are required for MPG viability:

- At least 50 percent of steelhead populations in the MPG achieve viability.
- Natural production of steelhead from tributaries to Puget Sound that are not identified in any of the 32 identified populations provides sufficient ecological diversity and productivity to support DPS-wide recovery.
- In addition to the minimum number of viable DIPs (50 percent) required above, all DIPs in the MPG must achieve an average MPG-level viability that is equivalent to or greater than the geometric mean (averaged over all the DIPs in the MPG) viability score of at least 2.2 using the 1–3 scale for individual DIPs described under the DIP viability discussion in the PSSTRT Viability Criteria document (Hard et al. 2015). This criterion is intended to ensure that MPG viability is not measured (and achieved) solely by the strongest DIPs, but also by other populations that are sufficiently healthy to achieve MPG-wide resilience. The Plan allows for an alternative evaluation method to that in Hard et al. (2015) may be developed and used to assess MPG viability.

The Plan (NMFS 2019g) also identified specific DIPs in each of the three MPGs which must attain viability. These DIPs, by MPG, are described as follows:

For the **North Cascades MPG** eight of the sixteen DIPs in the North Cascades MPG must be viable. The eight (five winter-run and three summer-run) DIPs described below must be viable to meet this criterion:

- Of the eleven DIPs with winter or winter/summer runs, five must be viable:
- Nooksack River Winter-Run;
- Stillaguamish River Winter-Run;
- One from the Skagit River (either the Skagit River Summer-Run and Winter-Run or the Sauk River Summer-Run and Winter-Run);
- One from the Snohomish River watershed (Pilchuck, Snoqualmie, or Snohomish/Skykomish River Winter-Run); and
- One other winter or summer/winter run from the MPG at large.

The rationale for this is that there are four major watersheds in this MPG, and one viable population from each will help attain geographic spread and habitat diversity within core extant steelhead habitat (NMFS 2019g). Of the five summer-run DIPs in this MPG, three must be viable, representing each of the three major watersheds containing summer-run populations

(Nooksack, Stillaguamish, Snohomish rivers). Therefore, the priority summer-run populations are as follows:

- South Fork Nooksack River Summer-Run;
- One DIP from the Stillaguamish River (Deer Creek Summer-Run or Canyon Creek Summer-Run); and
- One DIP from the Snohomish River (Tolt River Summer-Run or North Fork Skykomish River Summer-Run).

As described, these priority populations in the North Cascades MPG include specific, winter or winter/summer-run populations from the Nooksack, Stillaguamish, Skagit or Sauk, and Snohomish River basins and three summer-run populations from the Nooksack, Stillaguamish, and Snohomish basins. These populations are targeted to achieve viable status to support MPG viability. Having viable populations in these basins assures geographic spread, provides habitat diversity, reduces catastrophic risk, and increases life-history diversity (NMFS 2019g).

For the **Central and South Puget Sound MPG** four of the eight DIPs in the Central and South Puget Sound MPG must be viable. The four DIPs described below must be viable to meet this criterion:

- Green River Winter-Run;
- Nisqually River Winter-Run;
- Puyallup/Carbon rivers Winter-Run, or the White River Winter-Run; and
- At least one additional DIP from this MPG: Cedar River, North Lake Washington/Sammamish Tributaries, South Puget Sound Tributaries, or East Kitsap Peninsula Tributaries.

The rationale for this prioritization is that steelhead inhabiting the Green, Puyallup, and Nisqually River watersheds currently represent the core extant steelhead populations and these watersheds contain important diversity of stream habitats in the MPG.

For the **Hood Canal and Strait of Juan de Fuca MPG** four of the eight DIPs in the Hood Canal and Strait of Juan de Fuca MPG must be viable. The four DIPs described below must be viable to meet this criterion:

- Elwha River Winter/Summer-Run (see rationale below);
- Skokomish River Winter-Run;
- One from the remaining Hood Canal populations: West Hood Canal Tributaries Winter-Run, East Hood Canal Tributaries Winter-Run, or South Hood Canal Tributaries Winter-Run; and
- One from the remaining Strait of Juan de Fuca populations: Dungeness Winter-Run, Strait of Juan de Fuca Tributaries Winter-Run, or Sequim/Discovery Bay Tributaries Winter-Run.

The rationale for this prioritization is that the Elwha and Skokomish rivers are the two largest single watersheds in the MPG and bracket the geographic extent of the MPG. Furthermore, both

Elwha and Skokomish populations have recently exhibited summer-run life histories, although the Dungeness River population was the only summer/winter run in this MPG recognized by the PSSTRT in Hard et al. (2015). Two additional populations, one population from the Strait of Juan de Fuca area and one population from the Hood Canal area, are needed for a viable MPG to maximize geographic spread and habitat diversity.

Lastly, the Plan (NMFS 2019g) also identified additional attributes, or characteristics which should be associated with a viable MPG:

- All major diversity and spatial structure conditions are represented, based on the following considerations:
- Populations are distributed geographically throughout each MPG to reduce risk of catastrophic extirpation; and
- Diverse habitat types are present within each MPG (one example is lower elevation/gradient watersheds characterized by a rain-dominated hydrograph and higher elevation/gradient watersheds characterized by a snow-influenced hydrograph).

Federal and state steelhead recovery and management efforts will provide new tools and data and technical analyses to further refine PS steelhead population structure and viability, if needed, and better define the role of individual populations at the watershed level and in the DPS. Future consultations will incorporate information from the Plan (NMFS 2019g).

Spatial Structure and Diversity. The PS steelhead DPS includes all naturally spawned anadromous *O. mykiss* (steelhead) populations originating below natural and manmade impassable barriers from rivers flowing into Puget Sound from the Elwha River (inclusive) eastward, including rivers in Hood Canal, South Sound, North Sound and the Strait of Georgia. Non-anadromous ''resident'' *O. mykiss* 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. 2007). In October of 2016, NMFS proposed revisions to the hatchery programs included as part of Pacific salmon ESUs and steelhead DPSs listed under the ESA (81 FR 72759). NMFS issued its final rule in December of 2020 (85 FR 81822). This final rule includes steelhead from five artificial propagation programs in the PS steelhead DPS: the Green River Natural Program; White River Winter Steelhead Supplementation Program; Hood Canal Steelhead Supplementation Program; the Lower Elwha Fish Hatchery Wild Steelhead Recovery Program; and the Fish Restoration Facility Program. (85 FR 81822, December 17, 2020).

In 2013, the PSSTRT completed its evaluation of factors that influence the diversity and spatial structure VSP criteria for steelhead in the DPS. For spatial structure, this included the fraction of available intrinsic potential rearing and spawning habitat that is occupied compared to what is needed for viability[43]. For diversity, these factors included hatchery fish production, contribution of resident fish to anadromous fish production, and run timing of adult steelhead. Quantitative information on spatial structure and connectivity was not available for most PS steelhead populations, so a Bayesian Network framework was used to assess the influence of these factors on steelhead viability at the population, MPG, and DPS scales. The PSSTRT concluded that low

[43] Where intrinsic potential is the area of habitat suitable for steelhead rearing and spawning, at least under historical conditions (Puget Sound Steelhead Technical Recovery Team 2011; PSSTRT 2013).

population viability was widespread throughout the DPS and populations showed evidence of diminished spatial structure and diversity. Specifically, population viability associated with spatial structure and diversity was highest in the Northern Cascades MPG and lowest in the Central and South Puget Sound MPG (Puget Sound Steelhead Technical Recovery Team 2011). Diversity was generally higher for populations within the Northern Cascades MPG, where more variability in viability was expressed and diversity generally higher, compared to populations in both the Central and South Puget Sound and Hood Canal and Strait of Juan de Fuca MPG, where diversity was depressed and viabilities were generally lower (NWFSC 2015). Most PS steelhead populations were given intermediate scores for spatial structure and low scores for diversity because of extensive hatchery influence, low breeding population sizes, and freshwater habitat fragmentation or loss (NWFSC 2015). The PSSTRT concluded that the Puget Sound DPS was at very low viability, considering the status of all three of its constituent MPGs, and many of its 32 DIPs (Hard et al. 2015). For spatial structure there were a number of events that occurred in Puget Sound during the last review period (2015-2019) that are anticipated to improve status populations within several of the MPGs within the DPS.

Since the PSSTRT completed its 2013 review, the only additional spatial structure and diversity data that have become available have been estimates of the fraction of hatchery fish on the spawning grounds (NWFSC 2015). Since publication of the NWFSC report in 2015 and the 2022 NWFSC biological viability assessment update (Ford 2022), reductions in hatchery programs founded from non-listed and out of DPS stocks (i.e., Skamania) have occurred. In addition, the fraction of out of DPS hatchery steelhead spawning naturally are low for many rivers (NWFSC 2015; NMFS 2016i; 2016h). The fraction of natural-origin steelhead spawners was 0.9 or greater for the 2005-2009 and 2010-2014 time periods for all populations where data was available, but the Snoqualmie and Stillaguamish Rivers. For 17 of 22 DIPs across the DPS, the five-year average for the fraction of natural-origin steelhead spawners exceeded 0.75 from 2005 to 2009; this average was near 1.0 for 8 populations, where data were available, from 2010 to 2014 (NWFSC 2015). However, the fraction of natural-origin steelhead spawners could not be estimated for a substantial number of DIPs during the 2010 to 2014 period, or for the most recent 2015 – 2019 timeframe (NWFSC 2015; Ford 2022). In some river systems, such as the Green River, Snohomish/Skykomish Rivers, and the Stillaguamish Rivers these estimates were higher than some guidelines recommend (e.g., no more than 5percent hatchery-origin spawners on spawning grounds for isolated hatchery programs (HSRG 2009) over the 2005-2009 and 2010-2014 timeframes. The 2022 NWFSC biological viability assessment update (Ford 2022) states that a third of the 32 PS steelhead populations continue to lack monitoring and abundance data, and in most case, it is likely that abundances are very low.

Early winter-run fish produced in isolated hatchery programs are derived from Chambers Creek stock in southern Puget Sound, which has been selected for early spawn timing, a trait known to be inheritable in salmonids.[44] Summer-run fish produced in isolated hatchery programs were historically derived from the lower Columbia River Basin (i.e., from outside the DPS). The production and release of hatchery fish of both run types (winter and summer) may continue to pose risk to diversity in natural-origin steelhead in the DPS, as described in Hard et al. (2007) and Hard et al. (2015). However, the 2022 NWFSC biological viability assessment update (Ford 2022) states that risks to natural-origin PS steelhead that may be attributable to hatchery-related

[44] The natural Chambers Creek steelhead stock is now extinct.

effects has decreased since the 2015 status review due to reductions in production of non-listed stocks, and the replacement with localized stocks. The three summer steelhead programs continuing to propagate Skamania derived stocks from outside of Puget Sound should be phased out completely by 2031 (NMFS 2019c; Ford 2022). Lastly, annual reporting from the operators and current science suggest that risks remain at the same low to negligible levels as evaluated in 2016 and 2019 (NMFS 2016b; 2019c; 2019g; 2019a).

More information on PS steelhead spatial structure and diversity can be found in NMFS's PSSTRT viability report and NMFS's status review update on salmon and steelhead (NWFSC 2015; Ford 2022).

Abundance and Productivity. The viability of the PS steelhead DPS has improved somewhat since the Puget Sound Steelhead TRT concluded that the DPS was at very low viability, as were all three of its constituent MPGs, and many of its 32 DIPs (Hard et al. 2015). Increases in spawner abundance have been observed in a number of populations over the last five years; however, these improvements were disproportionately found within the South and Central Puget Sound and Strait of Juan de Fuca and Hood Canal MPGs, and primarily among smaller populations. The recent positive trends among winter-run populations in the White, Nisqually, and Skokomish rivers improve the demographic risks facing those populations. The abundance, productivity, spatial structure, and diversity of Elwha River steelhead winter and summer-runs has dramatically improved following the removal of the Elwha River dams improved. Improvements in abundance have not been as widely observed in the Northern Puget Sound MPG. The declines of summer and winter-run populations in the Snohomish Basin are especially concerning. These populations figure prominently as sources of abundance for the MPG and DPS (NMFS 2019a). Additionally, the decline in the Tolt River summer-run steelhead population was especially alarming given that it is the only summer-run population for which we have abundance estimates. The demographic and diversity risks to the Tolt River summer-run DIP are very high. In fact, all summer-run steelhead populations in the North Cascades MPG are likely at a very high demographic risk. In spite of improvements in some areas, most populations are still at relatively low abundance levels, with about a third of the DIPs unmonitored and presumably at very low levels (Ford 2022).

The PSSTRT was established by NOAA Fisheries and convened in March 2014 to develop a Recovery Plan for the PS steelhead DPS. This Recovery Plan was finalized in December 2019 (NMFS 2019a). Recovery targets were calculated using a two-tiered approach adjusting for years of low and high productivity. Abundance information is unavailable for approximately one-third of the DIPs, disproportionately so for summer-run populations. In most cases where no information is available it is assumed that abundances are very low. Some population abundance estimates are only representative of part of the population (index reaches, etc.). Where recent five-year abundance information is available, 30 percent (6 of 20 populations) are less than 10 percent of their high productivity recovery targets (lower abundance target), 65 percent (13 of 20) are between 10 and 50 percent, and 5 percent (1 of 20) are greater than 50 percent of their low abundance targets (Table 10). A key element to achieving recovery is recovering a representative number of both winter- and summer-run steelhead populations, and the restoration of viable summer-run DIPs is a long-term endeavor (NMFS 2019a). Fortunately, the relatively rapid reestablishment of summer-run steelhead in the Elwha River does provide a model for potentially re-anadromizing summer-run steelhead sequestered behind impassable dams.

Table 10. Recent (2015–19) 5-year geometric mean of raw natural spawner counts for Puget Sound steelhead populations and population groups compared with Puget Sound steelhead recovery plan high and low productivity recovery targets (NMFS 2019a). Asterisks indicate that the abundance is only a partial population estimate. Superscript 1s (1) indicate that these populations have a combined target. Abundance is compared to the high-productivity individual DIP targets. Colors indicate the relative proportion of the recovery target currently obtained: red = <10%, orange = 10% > x < 50%, yellow = 50% > x < 100%, green = >100% (Ford 2022).

		Abundance		
			Target	
MPG	Population	2015–19	High productivity	Low productivity
HCSJF	South Hood Canal	91	2,100	7,100
HCSJF	Eastside Hood Canal Tributaries	93	1,800	6,200
HCSJF	Skokomish River	958	2,200	7,300
HCSJF	Westside Hood Canal Tributaries	150	2,500	8,400
HCSJF	Dungeness River	408	1,200	4,100
HCSJF	Strait of Juan de Fuca Independent Tributaries	95	1,000	3,300
HCSJF	Elwha River	1,241	2,619	2,619
HCSJF	Sequim and Discovery Bay Tributaries	n/a	500	1,700
NC	Samish River/Bellingham Bay Tributaries	1,305*	1,800	6,100
NC	Nooksack River	1,906	6,500	21,700
NC	Skagit River	7,181*[1]	15,000	15,000
NC	Stillaguamish River	487	7,000	23,400
NC	Snohomish/Skykomish Rivers	690	6,100	20,600
NC	Pilchuck River	638	2,500	8,200
NC	Snoqualmie River	500	3,400	11,400
NC	Tolt River (SU)	40	300	1,200
NC	Drayton Harbor Tributaries	n/a	1,100	3,700
NC	South Fork Nooksack River (SU)	n/a	400	1,300
NC	Sauk River	[1]	15,000	15,000
NC	Nookachamps River	[1]	15,000	15,000
NC	Baker River	[1]	15,000	15,000
NC	Canyon Creek (SU)	n/a	100	400
NC	Deer Creek (SU)	n/a	700	2,300
NC	North Fork Skykomish River (SU)	n/a	200	500
CSPS	North Lake Washington Tributaries	n/a	4,800	16,000
CSPS	Cedar River	n/a	1,200	4,000
CSPS	Green River	1,282	5,600	18,700
CSPS	White River	130	3,600	12,000
CSPS	Puyallup/Carbon Rivers	136	4,500	15,100
CSPS	Nisqually River	1,368	6,100	20,500
CSPS	East Kitsap Tributaries	n/a	2,600	8,700
CSPS	South Sound Tributaries	n/a	6,300	21,200

There are a number of planned, ongoing, and completed actions that will likely benefit steelhead populations in the near term, but have not yet influenced adult abundance. Among these, the removal of the diversion dam on the Middle Fork Nooksack River, the Pilchuck Dam removal, passage improvements at Mud Mountain Dam, the ongoing passage program in the North Fork Skokomish River, and the planned passage program at Howard Hanson Dam. Dam removal in the Elwha River, and the resurgence of the endemic winter and summer-run steelhead populations have underscored the benefits of restoring fish passage. The Elwha River scenario is somewhat unique in that upstream habitat is in pristine condition and smolts emigrate into the Strait of Juan de Fuca and not Puget Sound or Hood Canal.

Improvements in spatial structure can only be effective if done in concert with necessary improvements in habitat. Habitat restoration efforts are ongoing, but land development and habitat degradation concurrent with increasing human population in the Puget Sound corridor may results in a continuing net loss of habitat. Recovery efforts in conjunction with improved ocean and climatic conditions have resulted in improved viability status for the majority of populations in this DPS; however, absolute abundances are still low, especially summer-run populations, and the DPS remains at high to moderate risk of extinction. However, since 2015, fifteen of the 21 populations indicate small to substantive increases in abundance.[45]. From 2015 to 2019, nine of the 21 steelhead populations had fewer than 250 natural spawners annually, and 12 of the 21 steelhead populations had 500 or fewer natural spawners. However, most steelhead populations remain small and the 15-year trend is still negative (Ford 2022)

Limiting factors. In our 2013 proposed rule designating critical habitat for this species (USDC 2013, 78 FR 2725), we noted that the following factors for decline for PS steelhead persist as limiting factors:

- 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 progeny from 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.

[45] Nooksack River, Samish River/Bellingham Bays Tributaries, Skagit River, Stillaguamish River, Pilchuck River, Cedar River, Green River, Puyallup River, Nisqually River, White River, S. Hood Canal, Eastside Hood Canal Tributaries, Westside Hood Canal Tributaries, Skokomish River and Elwha River winter-run populations. The Skagit River and Elwha River summer-run steelhead are also showing increasing trends (Ford 2022).

- Dikes, hardening of banks with riprap, and channelization, which have reduced river braiding and sinuosity, increasing the likelihood of gravel scour and dislocation of rearing juveniles.

PS steelhead Recovery Plan. Juvenile PS steelhead are less dependent on nearshore habitats for early marine rearing than Chinook or Chum salmon; nevertheless, nearshore, estuarine, and shoreline habitats provide important features necessary for the recovery of steelhead. PS steelhead spend only a few days to a few weeks migrating through the large fjord, but mortality rates during this life stage are critically high (Moore et al. 2010; Moore and Berejikian 2017). Early marine mortality of PS steelhead is recognized as a primary limitation to the species' survival and recovery (NMFS 2019a). Factors in the marine environment influencing steelhead survival include predation, access to prey (primarily forage fish), contaminants (toxics), disease and parasites, migration obstructions (e.g., the Hood Canal bridge), and degraded habitat conditions which exacerbate these factors.

The PS steelhead recovery plan identifies ten ecological concerns that directly impact salmon and steelhead:

- Habitat quantity (anthropogenic barriers, natural barriers, competition);
- Injury and mortality (predation, pathogens, mechanical injury, contaminated food);
- Food (altered primary productivity, food-competition, altered prey species composition and diversity);
- Riparian condition (riparian condition, large wood recruitment);
- Peripheral and transitional habitats (side channel and wetland condition, estuary conditions, nearshore conditions);
- Channel structure and form (bed and channel form, instream structural complexity);
- Sediment conditions (decreased sediment quantity, increased sediment quantity);
- Water quality (temperature, oxygen, gas saturation, turbidity, pH, salinity, toxic contaminants);
- Water quantity (increased water quality, decreased water quality, altered flow timing); and
- Population-level effects (reduced genetic adaptiveness, small population effects, demographic changes, life history changes).

The Puget Sound steelhead recovery plan and its associated appendix 3 includes specific recovery actions for the marine environment. General protection and restoration actions summarized from the plan include:

- Continue to improve the assessments of harbor seal predation rates on juvenile steelhead;
- Remove docks and floats which act as artificial haul-out sites for seals and sea lions;
- Consistent with the MMPA, test acoustic deterrents and other hazing techniques to reduce steelhead predation from harbor seals;
- Develop non-lethal actions for "problem animals and locations" to deter predation;
- Increase forage fish habitat to increase abundance of steelhead prey;
- Remove bulkheads and other shoreline armoring to increase forage fish;
- Acquire important forage fish habitat to protect high forage fish production areas;

- Add beach wrack to increase forage fish egg survival;
- Protect and restore aquatic vegetation (e.g., eelgrass and kelp);
- Remove creosote pilings to reduce mortality of herring eggs;
- Increase the assessment of migratory blockages, especially the Hood Canal bridge, where differential mortality has been documented;
- Identify and remedy sources of watershed chemical contaminants (e.g., PBDEs and PCBs).

Status of Rockfish

NMFS adopted a recovery plan for both PS/GB bocaccio and yelloweye rockfish in 2017. There are no published estimates of historic or present-day abundance of yelloweye rockfish bocaccio across the full DPSs area. In 2013, the Washington Department of Fish and Wildlife (WDFW) published abundance estimates from a remotely operated vehicle (ROV) survey conducted in 2008 in the San Juan Island area (Pacunski et al. 2013). This survey was conducted exclusively within rocky habitats and represents the best available abundance estimates to date for one basin of the DPS. The survey produced estimates of 47,407 (25 percent variance) yelloweye rockfish, and 4,606 (100 percent variance) PS/GB bocaccio in the San Juan area (Tonnes et al. 2016). Though the WDFW has produced other ROV-based estimates of rockfish biomass in Washington waters of the DPSs, none have both covered the entirety of the DPSs and had sufficient sample size to accurately estimate population size for rare species, such as yelloweye and bocaccio rockfish.

Using several available, but spatiotemporally patchy, data series on rockfish occurrence and abundance in Puget Sound Tolimieri et al. (2017) determined that total rockfish declined at a rate of 3.1 to 3.8 percent per year from 1977 to 2014, or a 69 to 76 percent total decline over that period. The two listed DPSs declined over-proportional compared to the total rockfish assemblage. Therefore, long-term population growth rate for the listed species was likely even lower (more negative) than that for total rockfish. While there is little to no evidence of recent recovery of total groundfish abundance in response to protective measures enacted over the last 25 years (Essington et al. 2013; 2021; van Duivenbode 2018), increases in the prevalence of several life stages of the more common rockfish species have been observed (Pacunski et al. 2020; LeClair et al. 2018). Given the slow maturation rate, episodic recruitment success, and rarity of yelloweye and bocaccio rockfish, combined with targeted fisheries being closed for over a decade, insufficient data exist to assess the recent recovery trajectory of these species.

Mature females of each listed species produce from several thousand to over a million eggs annually (Love et al. 2002). In rockfish, the number of embryos produced by the female increases exponentially with size (Haldorson and Love 1991). For example, female copper rockfish that are 20 cm in length produce 5,000 eggs while a female 50 cm in length may produce 700,000 eggs (Palsson et al. 2009). These specific observations come from other rockfish, not the two listed species, or for the listed species in areas outside the DPSs. However, the generality of maternal effects in *Sebastes* suggests that some level of age or size influence on reproduction is likely for all species (Haldorson and Love 1991).

Larval and newly settled rockfishes commonly rely on nearshore habitat. The nearshore is generally defined as habitats contiguous with the shoreline from extreme high water out to a depth no greater than 98 feet (30 m) relative to mean lower low water. This area generally coincides with the maximum depth of the photic zone of West Coast waters and can contains physical or biological features essential to the conservation of many fish and invertebrate species, including PS/GB bocaccio. Approximately 27 percent of Puget Sound's shoreline has been modified by armoring, altering sediment budget, wrack accumulation, and other biophysical processes, and in south-central Puget Sound over 60 percent of the shoreline is armored (Simenstad et al. 2011; Whitman 2011; Dethier et al. 2016). Nearshore habitats throughout the greater Puget Sound region have been affected by a variety of human activities, including agriculture, heavy industry, timber harvest, and the development of sea ports and residential property (Drake et al. 2010).

Juvenile yelloweye rockfish are not typically found in intertidal waters (Love et al. 1991; Studebaker et al. 2009). A few juveniles have been documented in shallow nearshore waters (Love et al. 2002; Palsson et al. 2009), but most settle in habitats along the shallow range of adult habitats in areas of complex bathymetry including rocky/boulder habitats and cloud sponges in waters greater than 98 feet (30 m) (Richards 1986; Love et al. 2002; Yamanaka et al. 2006). In British Columbia, juvenile yelloweye rockfish have been observed at a mean depth of 239 feet (73 m), with a minimum depth of 98 feet (30 m) (Yamanaka et al. 2006). In greater Puget Sound, juvenile yelloweye rockfish occur in similar habitats as adults, though in areas with smaller crevices, including cloud sponge formations, crinoid aggregations on top of rocky ridges, and over cobble substrates (Weispfenning 2006; Yamanaka et al. 2006; Banks 2007). Young-of-year bocaccio occur on shallow rocky reefs and nearshore areas, often associated with macroalgae, especially kelps (Laminariales), and sandy areas that support seagrasses (Moser 1967; Anderson 1983; Kendall and Lenarz 1986; Carr 1991; Love et al. 1991; Love 1996; Murphy et al. 2000; Love et al. 2002). They form aggregations near the bottom in association with drift algae and throughout the water column in association with canopy-forming kelps. It is likely that nearshore habitats used by juvenile bocaccio and other juvenile rockfish species offers a beneficial mix of warmer temperatures, food, and refuge from predators (Love et al. 1991). Habitat formed by kelp provides structure for feeding, refuge from predators, and reduced currents that enable energy conservation for juvenile bocaccio. Juvenile bocaccio are exceptionally rare in greater Puget Sound, casting some doubt on whether the current population is capable of reproducing at a rate sufficient to support recovery (Palsson et al. 2009; Drake et al. 2010; NMFS 2017a).

The alteration of Puget Sound shorelines has been found to impact a variety of marine life, ranging from invertebrate fauna (Sobocinski 2003) to surf smelt egg viability (Rice 2006), but consequences of the alteration of Puget Sound shorelines on rockfish habitat such as kelp are less well understood. Some areas around Puget Sound have shown a large decrease in kelp (Berry et al. 2021). Areas with floating and submerged kelp (families *Chordaceae, Alariaceae, Lessoniacea, Costariaceae, and Laminarice*a) support the highest densities of most juvenile rockfish species (Matthews 1989; Halderson and Richards 1987; Carr 1983; Hayden-Spear 2006). Kelp habitat provides structure for feeding, predation refuge, and reduced currents that enable energy conservation for juveniles (Love et al. 1991). Loss of nearshore habitat quality is a threat to rockfish, but the factors driving this loss vary throughout the DPSs. As such, the recovery plan lists the severity of this threat as very low in Canada, low in the San Juan Islands, moderate in Hood Canal, and high in the Main Basin and South Sound (NMFS 2017a).

A study of rockfish in Puget Sound found that larval rockfish appeared to occur in two peaks (early spring, late summer) that coincide with the main primary production peaks in Puget Sound (Greene and Godersky 2012). Both measures indicated that rockfish ichthyoplankton essentially disappeared from the surface waters by the beginning of November. Densities also tended to be lower in the more northerly basins (Whidbey and Rosario), compared to the Central and South Sound (Greene and Godersky 2012).

The U.S. portion of the Puget Sound/Georgia Basin that is occupied by yelloweye rockfish and PS/GB bocaccio can be divided into five areas, or Basins, based on the distribution of each species, geographic conditions, and habitat features. These five interconnected Basins are: (1) The San Juan/Strait of Juan de Fuca Basin, (2) Main Basin, (3) Whidbey Basin, (4) South Puget Sound, and (5) Hood Canal. See 79 FR 68041, Nov. 13, 2014 (Puget Sound/Georgia Basin Distinct Population Segments of Yelloweye Rockfish, Canary Rockfish and Bocaccio; Designation of Critical Habitat).
Status of PS/GB Bocaccio

Status of PS/GB of Bocaccio

PS/GB bocaccio distribution within the DPS may have been historically spatially limited to a few key basins. Historical data indicate they were most abundant in the Central and South Sound with no documented occurrences in the San Juan Basin until 2008 (Pacunski et al.2013). The apparent decrease in PS/GB bocaccio population size in the Main Basin and South Sound could result in further reduction in the historically limited distribution of PS/GB bocaccio, and adds significant risk to long-term viability of the DPS.

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

<u>General Life History:</u> The life history of PS/GB bocaccio includes a pelagic larval stage followed by a juvenile stage, and occupation of progressively deeper benthic habitats during subadult and adult stages. As with other rockfish, PS/GB bocaccio fertilize their eggs internally and the young are extruded as larvae that are about 4 to 5 mm in length. Females produce from several thousand to over a million offspring per spawning (Love et al. 2002). The timing of larval parturition in PS/GB bocaccio is uncertain, but likely occurs within a five- to six-month window that is centered near March (Greene and Godersky 2012; NMFS 2017a; Palsson et al. 2009). Larvae are distributed by prevailing currents until they are large enough to actively swim toward preferred habitats, but they can pursue food within short distances immediately after birth (Tagal et al.

2002). Larvae are distributed throughout the water column (Weis 2004), but are also observed under free-floating algae, seagrass, and detached kelp (Love et al. 2002; Shaffer et al. 1995). Unique oceanographic conditions within Puget Sound, such as shallow sills and ample freshwater inputs, likely result in most larvae staying within the basin where they are released rather than being broadly dispersed (Drake et al. 2010). Recent modeling of passive particles serving as larval rockfish analogs, however, has demonstrated that this assumption can be substantially violated under certain conditions, resulting in larval transport among basins as well out both into and out of the DPS (Andrews et al. 2020).

At about 3 to 6 months old and 1.2 to 3.6 inches (3 to 9 cm) long, juvenile PS/GB bocaccio gravitate to shallow nearshore waters where they settle and grow. Rocky or cobble substrates with kelp is most typical, but sandy areas with eelgrass are also utilized for rearing (Carr 1983; Halderson and Richards 1987; Hayden-Spear 2006; Love et al. 1991 and 2002; Matthews 1989; NMFS 2017a; Palsson et al. 2009). Young of the year rockfish may spend months or more in shallow nearshore rearing habitats before transitioning toward deeper water habitats (Palsson et al. 2009). As PS/GB bocaccio grow, their habitat preference shifts toward deeper waters with high relief and complex bathymetry, including rock and boulder-cobble complexes (Love et al. 2002), but they also utilize non-rocky substrates such as sand, mud, and other unconsolidated sediments (Miller and Borton 1980; Washington 1977). Adults are most commonly found between 131 to 820 feet (40 to 250 m) (Love et al. 2002; Orr et al. 2000). The maximum age of PS/GB bocaccio is unknown, but may exceed 50 years, and they reach reproductive maturity near age six.

<u>Spatial Structure and Diversity:</u> The PS/GB bocaccio DPS includes all bocaccio from inland marine waters east of the central Strait of Juan de Fuca and south of the northern Strait of Georgia, collectively known as the Salish Sea. The waters of Puget Sound and Straits of Georgia can be divided into five interconnected basins that are largely hydrologically isolated from each other by relatively shallow sills (Burns 1985; Drake et al. 2010). The basins within US waters are: (1) San Juan, (2) Main, (3) South Sound, and (4) Hood Canal. The fifth basin consists of Canadian waters east and north of the San Juan Basin into the Straits of Georgia (Tonnes et al. 2016). Although most individuals of the PS/GB bocaccio DPS are believed to remain within the basin of their origin, including larvae and pelagic juveniles, some movement between basins occurs, and the DPS is currently considered a single population. Research intended to assess this assumption using genetic techniques was unable to collect sufficient samples for analysis (Andrews et al. 2018), but is ongoing.

<u>Abundance and Productivity:</u> The PS/GB bocaccio DPS exists at very low abundance and observations are relatively rare. No reliable range-wide historical or contemporary population estimates are available for the PS/GB bocaccio DPS. It is believed that prior to contemporary fishery removals, each of the major PS/GB basins likely hosted relatively large, though unevenly distributed, populations of PS/GB bocaccio. They were likely most common within the South Sound and Main Basin, but were never a predominant segment of the total rockfish abundance within the region (Drake et al. 2010). Bocaccio were not documented in any fishery or research record in the San Juans until 2008 (Pacunski et al. 2013). The best available information indicates that between 1965 and 2007, total rockfish populations have declined by about 70

percent in the Puget Sound region, and that PS/GB bocaccio have declined by an even greater extent (Drake et al. 2010; Tonnes et al. 2016; NMFS 2017a).

Limiting Factors: Factors limiting recovery for PS/GB bocaccio include:

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

Status of PS/GB Yelloweye Rockfish

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

Spatial Structure. Yelloweye rockfish occupy the waters of the Pacific coast from California to Alaska. Yelloweye rockfish in the waters of the Puget Sound/Georgia Basin were determined to be a DPS and this water later confirmed using genetic techniques (Andrews et al. 2018). The PS/GB DPS of yelloweye rockfish was listed as “threatened” under the ESA on April 28, 2010 (75 FR 22276). The DPSs include all yelloweye rockfish found in waters of Puget Sound, the Strait of Juan de Fuca east of Victoria Sill, the Strait of Georgia, and Johnstone Strait.

Diversity. Recent collection and analysis of PS/GB yelloweye rockfish tissue samples revealed significant genetic differentiation between the inland (DPS) and coastal samples (Andrews et al. 2018). These new data are consistent with and further support the existence of a population of PS/GB yelloweye rockfish that is discrete from coastal populations, an assumption that was made at the time of listing based on proxy species including quillback and copper rockfish (Ford 2015; Tonnes et al. 2016). In addition, yelloweye rockfish from Hood Canal were genetically differentiated from other PS/GB yelloweye, indicating a previously unknown degree of population differentiation within the DPS (Ford 2015; Tonnes et al. 2016; Andrews et al. 2018). Other genetic analysis has found that yelloweye rockfish in the Georgia Basin had the lowest molecular genetic diversity of a collection of samples along the coast (Siegle et al. 2013). Although the adaptive significance of such microsatellite diversity is unclear, it may suggest low effective population size, increased drift, and thus lower genetic diversity in the PS/GB DPS.

Abundance. Yelloweye rockfish within U.S. waters of the PS/GB are very likely the most abundant within the San Juan and Hood Canal Basins. Yelloweye rockfish spatial structure and connectivity is threatened by the apparent reduction of fish within each of the basins of the DPS, as they were once prized fishery targets. This reduction is probably most acute within the basins of Puget Sound proper. The severe reduction of fish in these basins may eventually result in a contraction of the DPS’ range. Recent research has found evidence for two populations of yelloweye rockfish within the DPS—one in Hood Canal and one within the rest of the PS/GB (Andrews et al. 2018).

In Puget Sound, catches of PS/GB yelloweye rockfish have declined as a proportion of the overall rockfish catch (Figure 2 and Figure 3, from Drake et al. 2010). Analysis of SCUBA surveys, recreational catch, and WDFW trawl surveys indicated total rockfish populations in the Puget Sound region are estimated to have declined between 3.1 and 3.8 percent per year for the past several decades, which corresponds to a 69 to 76 percent decline from 1977 to 2014 (Tonnes et al. 2016)

Productivity. Life history traits of yelloweye rockfish and PS/GB bocaccio suggest generally low levels of inherent productivity because they are long-lived, mature slowly, and have sporadic episodes of successful reproduction (Musick 1999; Tolimieri and Levin 2005). Yelloweye rockfish productivity may also be impacted by an Allee effect. This situation arises when reproductive adults are removed from the population and remaining individuals are eventually unable to encounter mates. This process then further reduces population density and can lead to extinction. Adult PS/GB yelloweye rockfish typically occupy relatively small ranges (Love et al. 2002), and the extent to which they may move to find suitable mates is unknown. However, there is insufficient information to determine that this is currently occurring for yelloweye rockfish and further research is needed (Hutchings and Reynolds 2004).

Status of Southern Resident Killer Whales (SRKWs)

The SRKW DPS, composed of J, K, and L pods, was listed as endangered under the ESA on November 18, 2005 (70 FR 69903). A 5-year review under the ESA completed in 2021 concluded that SRKWs should remain listed as endangered and includes recent information on the population, threats, and new research results and publications (NMFS 2021b).

NMFS considers SRKWs to be currently among nine of the most at-risk species as part of the Species in the Spotlight initiative[46] because of their endangered status, declining population trend, and because they are high priority for recovery based on conflict with human activities and recovery programs in place to address threats. The population has relatively high mortality and low reproduction unlike other resident killer whale populations that have generally been increasing since the 1970s (Carretta et al. 2021).

The limiting factors described in the final recovery plan included reduced prey availability and quality, high levels of contaminants from pollution, and disturbances from vessels and sound (NMFS 2008a). This section summarizes the status of SRKWs throughout their range and summarizes information taken largely from the recovery plan (NMFS 2008a), most recent 5-year review (NMFS 2021b), the Pacific Fishery Management Council (PFMC) SRKW Ad Hoc Workgroup's report (PFMC 2020), as well as newly available data.

Abundance, Productivity, and Trends. Killer whales—including SRKWs—are a long-lived species and sexual maturity can occur at age ten (NMFS (2008a)). Females produce a low number of surviving calves (n < 10, but generally fewer) over the course of their reproductive life span (Bain 1990; Olesiuk et al. 1990). Compared to Northern Resident killer whales

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[46] https://www.fisheries.noaa.gov/resource/document/species-spotlight-priority-actions-2016-2020-southern-resident-killer-whale

(NRKWs), which are a resident killer whale population with a sympatric geographic distribution ranging from coastal waters of Washington State and British Columbia north to Southeast Alaska, SRKW females appear to have reduced fecundity (Ward et al. 2013; Vélez-Espino et al. 2014), and all age classes of SRKWs have reduced survival compared to other fish-eating populations of killer whales in the Northeast Pacific (Ward et al. 2013).

Since the early 1970s, annual summer censuses in the Salish Sea using photo-identification techniques have occurred (Bigg et al. 1990; Center for Whale Research 2019). The population of SRKW was at its lowest known abundance in the early 1970s following live-captures for aquaria display (n = 68). The highest recorded abundance since the 1970s was in 1995 (98 animals), though the population declined from 1995-2001 (from 98 whales in 1995 to 81 whales in 2001). The population experienced a growth between 2001 and 2006 and has been generally declining since then. However, in 2014 and 2015, the SRKW population increased from 78 to 81 as a result of multiple successful pregnancies (n = 9) that occurred in 2013 and 2014. At present, the SRKW population has declined to near historically low levels (Figure 5). As of September 2021, the population is 74 whales, including 24 whales in J pod, 17 whales in K pod, and 33 whales in L pod, including two calves born to J pod in September 2020 and one new calf to the L pod in February 2021 (Center for Whale Research 2021). The previously published historical estimated abundance of SRKW is 140 animals (NMFS 2008a). This estimate (~140) was generated as the number of whales killed or removed for public display in the 1960s and 1970s (summed over all years) added to the remaining population at the time the captures ended.

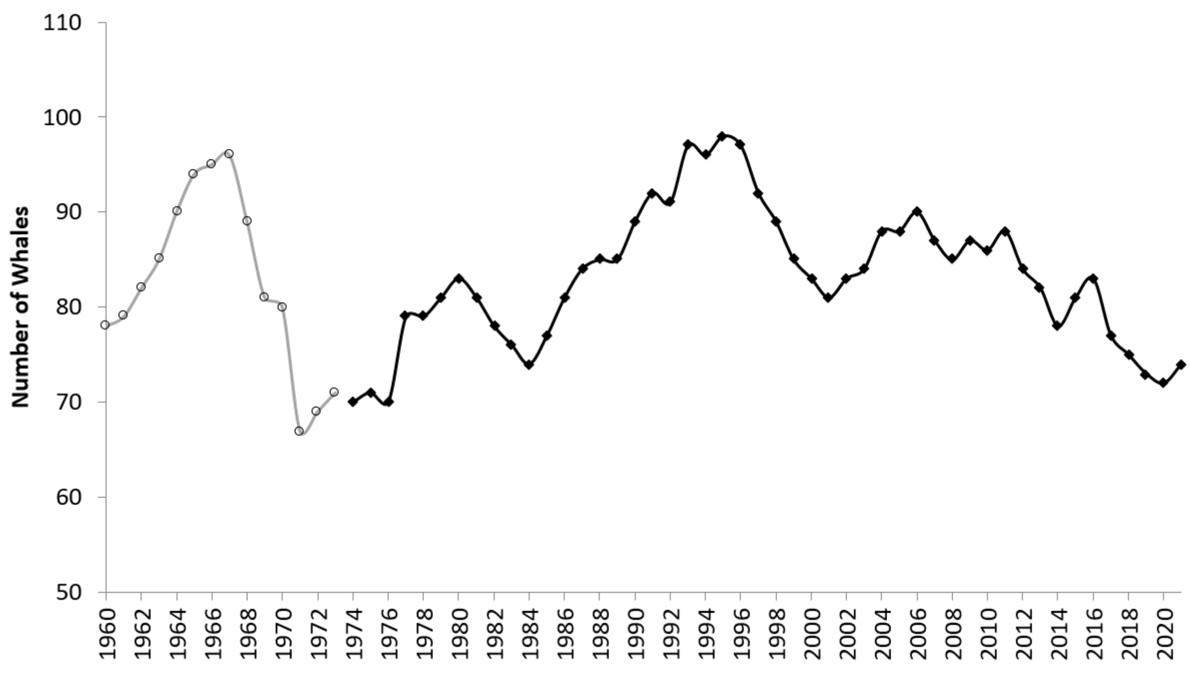

Figure 5. Population size and trend of Southern Resident killer whales, 1960-2021. Data from 1960-1973 (open circles, gray line) are number projections from the matrix model of Olesiuk et al. (1990). Data from 1974-2021 (diamonds, black line) were obtained through photo-identification surveys of the three pods (J, K, and L) in this community and were provided by the Center for Whale Research

(unpublished data) and NMFS (2008a). Data for these years represent the number of whales present at the end of each calendar year, or after the summer census for 2012 onwards.

Based on an updated pedigree from new genetic data, many of the offspring in recent years were sired by two fathers, meaning that less than 30 individuals make up the effective reproducing portion of the population. Because a small number of males were identified as the fathers of many offspring, a smaller number may be sufficient to support population growth than was previously thought (Ford et al. 2011; Ford et al. 2018). However, the consequence of this means inbreeding may be common amongst this small population, with a recent study by Ford et al. (2018) finding several offspring resulting from matings between parents and their own offspring. The fitness effects of this inbreeding remain unclear and are an effort of ongoing research (Ford et al. 2018).

Seasonal mortality rates among Southern and Northern Resident whales may be highest during the winter and early spring, based on the numbers of animals missing from pods returning to inland waters each spring and standings data. Olesiuk et al. (2005) identified high neonatal mortality that occurred outside of the summer season, and multiple new calves have been documented in winter months that have not survived the following summer season (Center for Whale Research, unpublished data). Stranding rates are higher in winter and spring for all killer whale forms in Washington and Oregon (Norman et al. 2004) and a recent review of killer whale strandings in the northeast Pacific provided insight into health, nutritional status and causes of mortality for all killer whale ecotypes (Raverty et al. 2020).

The NWFSC continues to evaluate changes in fecundity and mortality rates, and has updated the population viability analyses conducted for the 2004 Status Review for SRKWs and the 2011 science panel review of the effects of salmon fisheries (Krahn et al. 2004; Hilborn et al. 2012; Ward et al. 2013) and the most recent 5-year review (NMFS 2021b). The updated analysis[47] described the recent changes in population size and age structure, change in demographic rates over time, and updated projections of population viability (Ward 2019). According to Ward (2019), the model results indicate that fecundity rates have declined and have changed more than male or female survival since 2010. Ward (2019) performed a series of projections: (1) projections using fecundity and survival rates estimated over the long-term data series (1985 to 2019); (2) projections using fecundity and survival rates from the most recent 5 year period (2014 to 2019); and (3) projections using the highest fecundity and survival rates estimated (in the period 1985 to 1989). The most optimistic scenario, using demographic rates calculated from the 1985 to1989 period, has a trajectory that increases and eventually declines after 2030, while the scenario with long-term demographic data, or the scenario only including the most recent years' demographic data, project declines. Additional runs for this scenario (1985 to1989 data) indicated a similar trajectory with a 50:50 sex ratio. Thus, the downward trends are likely driven by the current age and sex structure of young animals in the population (from 2011-2016 new

[47] There are several methodological changes from the projections done previously (Hilborn et al. 2012; Ward et al. 2013). First, because indices of salmon abundance available to whales is not included in the model (and none of the existing metrics of salmon abundance have been found to correlate with killer whale demography; (PFMC 2020)), the estimation model was switched to a generalized additive model (GAM), which allows for smoother over year effects (Ward 2019).

births were skewed slightly toward males with 64 percent male), as well as the number of older animals (Ward 2019). As the model projects out over a longer time frame (50 years) there is increased uncertainty around the estimates. The downward trend is in part due to the changing age and sex structure of the population. If the population of SRKW experiences demographic rates (e.g. fecundity and mortality) that are more similar to 2016 than the recent 5-year average (2011to 2016), the population will decline faster as shown in Figure 6 (NMFS 2016b). There are several demographic factors of the SRKW population that are cause for concern, namely (1) reduced fecundity; (2) a skewed sex ratio toward male births in recent years; (3) a lack of calf production from certain components of the population (e.g. K pod); (4) a small number of adult males acting as sires (Ford et al. 2018); and (5) an overall small number of individuals in the population (NMFS 2016b).

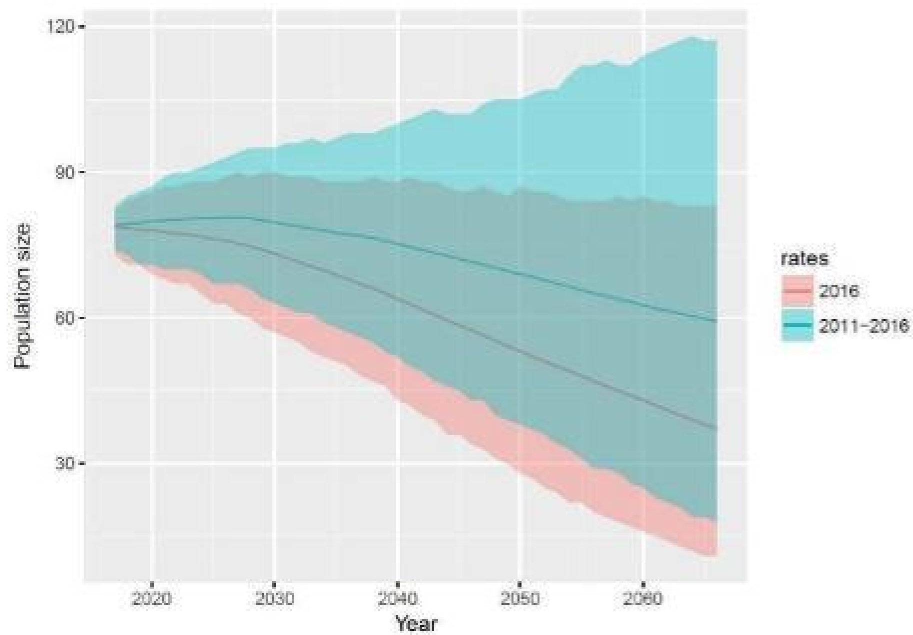

Figure 6. SRKW population size projections from 2016 to 2066 using two scenarios: (1) projections using demographic rates held at 2016 levels, and (2) projections using demographic rates from 2011 to 2016. The pink line represents the projection assuming future rates are similar to those in 2016, whereas the blue represents the scenario with future rates being similar to 2011 to 2016 (NMFS (2016b)).

Because of the whales' small population size, the population is also susceptible to increased risks of demographic stochasticity—randomness in the pattern of births and deaths among individuals in a population. Several sources of demographic variance (e.g. differences between individuals or within individuals) can affect small populations and contribute to variance in a population's growth and increased extinction risk. Sources of demographic variance can include environmental stochasticity, or fluctuations in the environment that drive changes in birth and death rates, and demographic heterogeneity, or variation in birth or death rates of individuals because of differences in their individual fitness (including sexual determinations). In combination, these and other sources of random variation combine to amplify the probability of extinction, known as the extinction vortex (Gilpin and Soulé 1986; Fagan and Holmes 2006;

Melbourne and Hastings 2008). The larger the population size, the greater the buffer against stochastic events and genetic risks.

Population-wide distribution of lifetime reproductive success of SRKWs can be highly variable, such that some individuals produce more offspring than others to subsequent generations, and male variance in reproductive success can be greater than that of females (e.g. Clutton-Brock 1998; Hochachka 2006). For long-lived vertebrates such as killer whales, some females in the population might contribute less than the number of offspring required to maintain a constant population size (n = 2), while others might produce more offspring. The smaller the population, the more weight an individual's reproductive success has on the population's growth or decline (Coulson et al. 2006). For example, the overall number of reproductive females has been fluctuating between 25 and 35 for most of the last 40 years, and there have been contrasting changes by pod, with declines in L pod females and increases in J pod (Ward 2019). At the start of the survey in 1976, the distribution of females was skewed toward younger ages with few older, post-reproductive females. The distribution in recent years is more uniform across female ages (in other words, more females in their 30s, (Ward 2019)). However, from 2014 through July 2019, only 7 calves were born and survived (3 in J pod and 4 in L pod) (Ward 2019). In a novel study, researchers collected SRKW feces to measure pregnancy hormones (progesterone and testosterone) (Wasser et al. 2017). The fecal hormone data showed that up to 69 percent of the detected pregnancies do not produce a documented calf, and an unprecedented half of those occurred relatively later in the pregnancy when energetic costs and physiological risk to the mother are higher (Wasser et al. 2017). Recent aerial imagery corroborates this high rate of loss (Fearnbach and Durban unpubl. data). The congruence between the rate of loss estimates from fecal hormones and aerial photogrammetry suggests the majority of the loss is in the latter half of pregnancy when photogrammetry can detect anomalous shape after several months of gestation (Durban et al. 2016). Although the rates of successful pregnancies in wild killer whale populations is generally unknown, a relatively high level of reproductive failure late in pregnancy is uncommon in mammalian species and suggests there may be cause for concern.

Geographic Range and Distribution. SRKWs occur throughout the coastal waters off Washington, Oregon, and Vancouver Island and are known to travel as far south as central California and as far north as Southeast Alaska (NMFS 2008a; Carretta et al. 2021; Ford et al. 2017) (Figure 7). SRKW are highly mobile and can travel up to approximately 86 miles (160 km) in a single day (Erickson 1978; Baird 2000), with seasonal movements likely tied to the migration of their primary prey, salmon. During the spring, summer, and fall months, SRKWs have typically spent a substantial amount of time in the inland waterways of the Strait of Georgia, Strait of Juan de Fuca, and Puget Sound (Bigg 1982; Ford et al. 2000; Krahn et al. 2002; Hauser et al. 2007). During fall and early winter, SRKWs, and J pod in particular, expand their routine movements into Puget Sound, likely to take advantage of chum, coho, and Chinook salmon runs (Osborne 1999; Hanson et al. 2010; Ford et al. 2016). Although seasonal movements are somewhat predictable, there can be large inter-annual variability in arrival time and days present in inland waters from spring through fall, with late arrivals and fewer days present in recent years (Hanson and Emmons 2010; The Whale Museum unpubl. data).

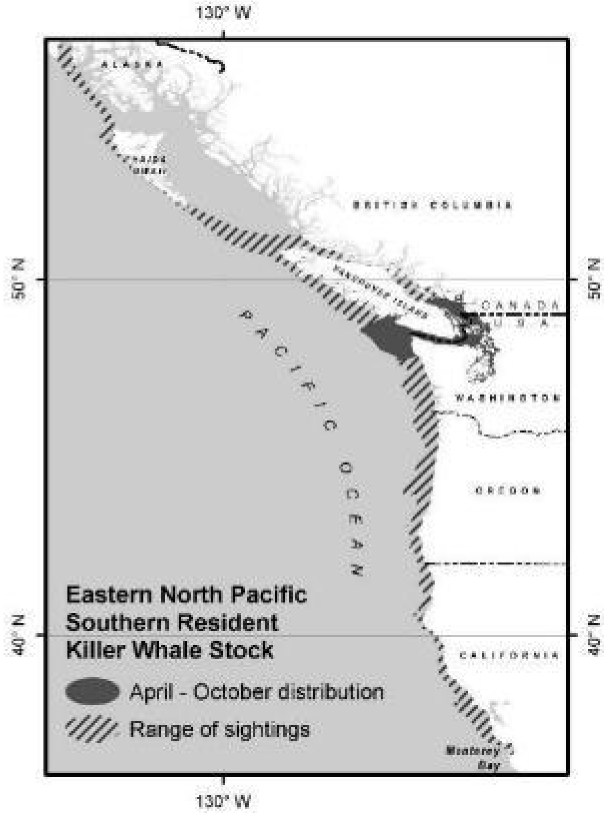

Figure 7. Approximate April–October distribution of SRKW (shaded area) and range of sightings (diagonal lines) (reprinted from Carretta et al. (2021)).

Land- and vessel-based opportunistic and survey-based visual sightings, satellite tracking, and passive acoustic research conducted have provided an updated estimate of the whales' coastal range that extends from the Monterey Bay area in California, north to Chatham Strait in southeast Alaska. Since 1975, confirmed and unconfirmed opportunistic SRKW sightings from the general public or researchers have been collected off British Columbia, Washington, Oregon, and California. Because of the limitations of not having controlled and dedicated sampling efforts, these confirmed opportunistic sightings have provided only general information on the whales' potential geographic range during this period of time (*i.e.,* there are no data to describe the whales' general geographic range prior to 1975). Together, these SRKW sightings have confirmed their presence as far north as Chatham Strait, southeast Alaska and as far south as Monterey Bay, California (NMFS 2019b).

As part of a collaborative effort between NWFSC, Cascadia Research Collective and the University of Alaska, satellite-linked tags were deployed on eight male SRKW (three tags on J pod members, two on K pod, and three on L pod) from 2012 to 2016 in Puget Sound or in the coastal waters of Washington and Oregon (Table 9). The tags transmitted multiple locations per day to assess winter movements and occurrences of SRKW (Hanson et al. 2017).

Over the course of the study, the eight satellite tags deployed were monitored for a range of signal contact durations from 3 days to 96 days depending on the tag, with deployment from late December to mid-May (Table 11). The winter locations of the tagged whales included inland and coastal waters. The inland waters range occurs across the entire Salish Sea, from the northern end of the Strait of Georgia and Puget Sound, and coastal waters from central west coast of Vancouver Island, British Columbia to northern California (Hanson et al. 2017). The tagging data from 2012 to 2016 provided general information on the home range and overlap of each pod, and areas that are used more frequently than others by each pod. Specifically, J pod had high use areas (defined as 1 to 3 standard deviations) in the northern Strait of Georgia and the west entrance to the Strait of Juan de Fuca where they spent approximately 30 percent of their time there (Figure 9), but they spent relatively little time in other coastal areas. K/L pods occurred almost exclusively on the continental shelf during December to mid-May, primarily on the Washington coast, with a continuous high use area between Grays Harbor and the Columbia River and off Westport and spending approximately 53 percent of their time there (Figure 8) (Hanson et al. 2017, 2018). These differences resulted in generally minimal overlap between J pod and K/L pods, with overlap in high use areas near the Strait of Juan de Fuca western entrance for only a total area of approximately 200 km^2, which comprised only 0.5 percent of the three pods' ranges.

Satellite tagging can also provide details on preferred depths and distances from shore. Approximately 95 percent of the SRKW locations were within 34 km of the shore and 50 percent of these were within 10 km of the coast (Hanson et al. 2017). Only 5 percent of locations were greater than 34 km away from the coast, but no locations exceeded 75 km. Almost all (96.5 percent) outer coastal locations of satellite-tagged Southern Residents occurred in continental shelf waters of 200 m (656.2 ft) depth or less, 77.7 percent were in waters less than 100 m (328.1 ft) depth, and only 5.3 percent were in waters less than 18 m (59 ft).

Table 11. Satellite-linked tags deployed on SRKW 2012-2016. (Hanson et al. 2018). This was part of a collaborative effort between NWFSC, Cascadia Research Collective, and the University of Alaska.

Whale ID	Pod association	Date of tagging	Duration of signal contact (days)
J26	J	20 Feb. 2012	3
L87	J	26 Dec. 2013	31
J27	J	28 Dec. 2014	49
K25	K	29 Dec. 2012	96
L88	L	8 Mar. 2013	8
L84	L	17 Feb. 2015	93
K33	K	31 Dec. 2015	48
L95	L	23 Feb. 2016	3

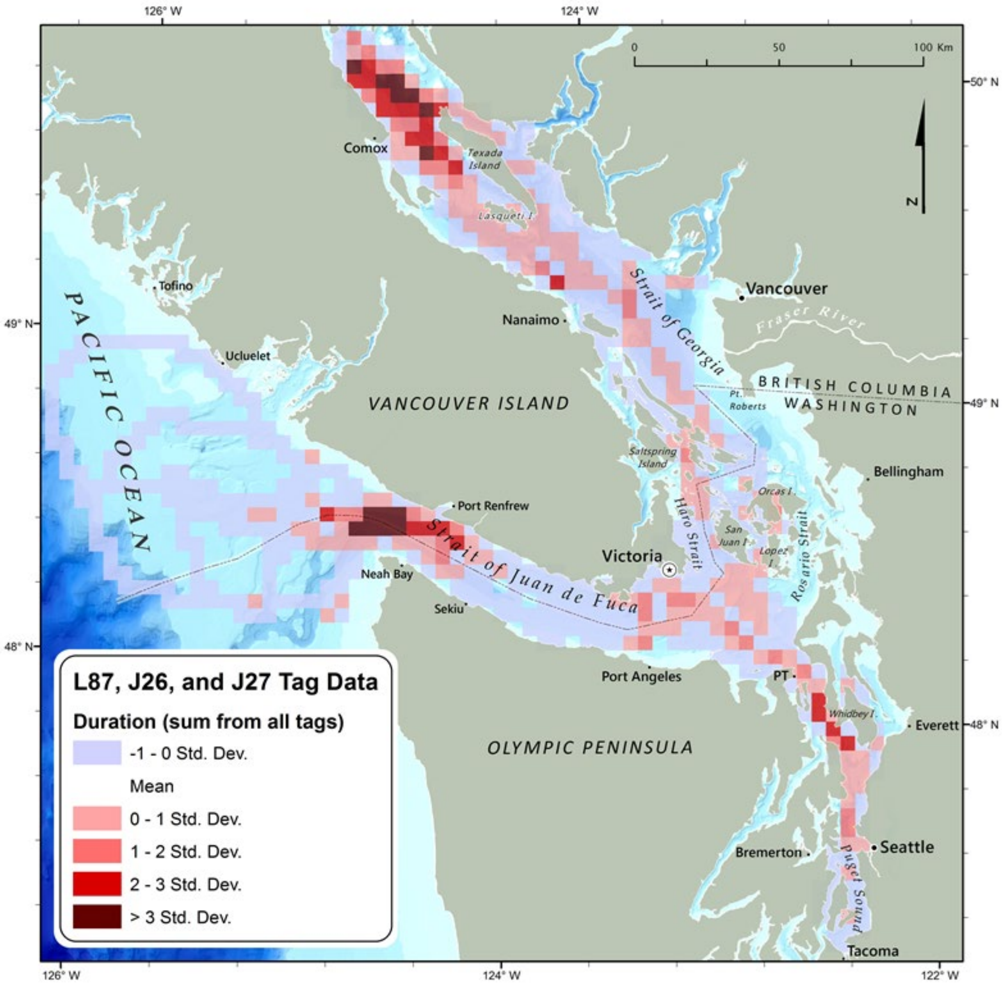

Figure 8. Duration of occurrence model output for J pod tag deployments (Hanson et al. 2017). "High use areas" are illustrated by the 0 to > 3 standard deviation pixel**.** Duration of occurrence model for all unique K and L pod tag deployments (Hanson et al. 2017). "High use areas" are illustrated by the 0 to > 3 standard deviation pixels.

Passive acoustic recorders were deployed off the coasts of California, Oregon and Washington in most years since 2006 to assess their seasonal uses of these areas via the recording of stereotypic calls of the SRKW (Hanson et al. 2013; Emmons et al. 2019). Passive aquatic listeners (PALs) were originally deployed from 2006–2008. Since 2008, four to seventeen Ecological Acoustic Recorders have been deployed. From 2006–2011, passive acoustic listeners and recorders were deployed in areas thought to be of frequent use by SRKWs based on previous sightings, where enhanced productivity was expected to be concentrated, and in areas with a reduced likelihood of fisheries interactions (Hanson et al. (2013)). The number of recorder sites off the Washington coast increased from 7 to 17 in the fall of 2014 and locations were selected based on "high use areas" identified in the duration of an occurrence model (Figure 10), and sites within the U.S. Navy's Northwest Training Range Complex (NWTRC) in order to determine if SRKWs used these areas in other seasons when satellite-linked tags were not deployed (Hanson et al. 2017; Emmons et al. 2019). "High use areas" for the SRKW in winter were determined to be primarily located in three areas: (1) the Washington coast, particularly between Grays Harbor and the mouth of the Columbia River (primarily for K/L pods); (2) the west entrance to the Strait of Juan de Fuca (primarily for J pod); and (3) the northern Strait of Georgia (primarily for J pod). It is important to note that recorders deployed within the NWTRC were designed to assess spatial use off Washington coast and thus the effort was higher in this area (i.e., the number of recorders increased in this area) compared to off Oregon and California.

There were acoustic detections off Washington coast in all months of the year (Figure 11), with greater than 2.4 detections per month from January through June and a peak of 4.7 detections per month in both March and April, indicating that the SRKW may be present in Washington coastal waters at nearly any time of year, and in other coastal waters more often than previously believed (Hanson et al. 2017). Acoustic recorders were deployed off Newport, Fort Bragg, and Port Reyes between 2008 through 2013 and SRKW were detected 28 times (Emmons et al. 2019).

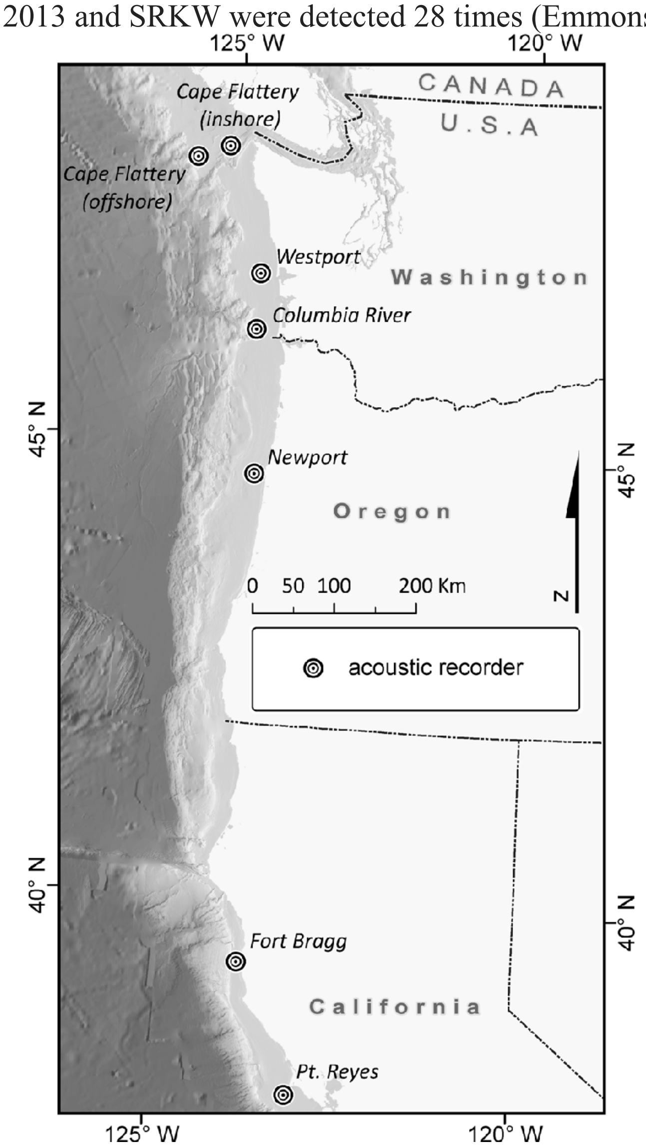

Figure 9. Deployment locations of acoustic recorders on the U.S. west coast from 2006 to 2011 (Hanson et al. 2013).

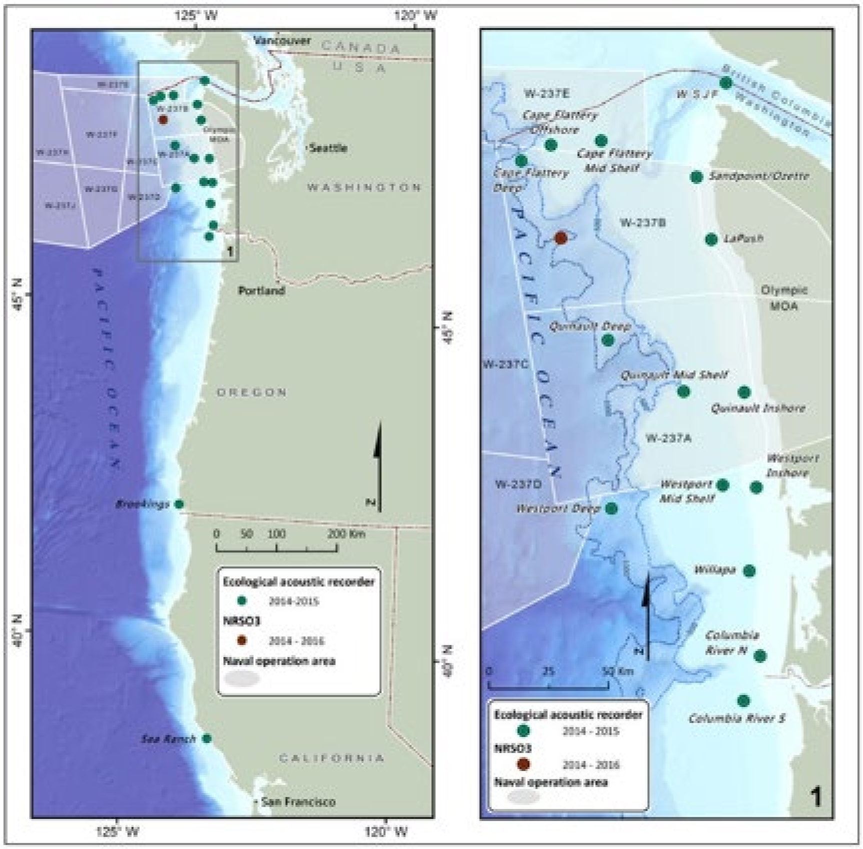

Figure 10. Locations of passive acoustic recorders deployed beginning in the fall of 2014 (Hanson et al. 2017).

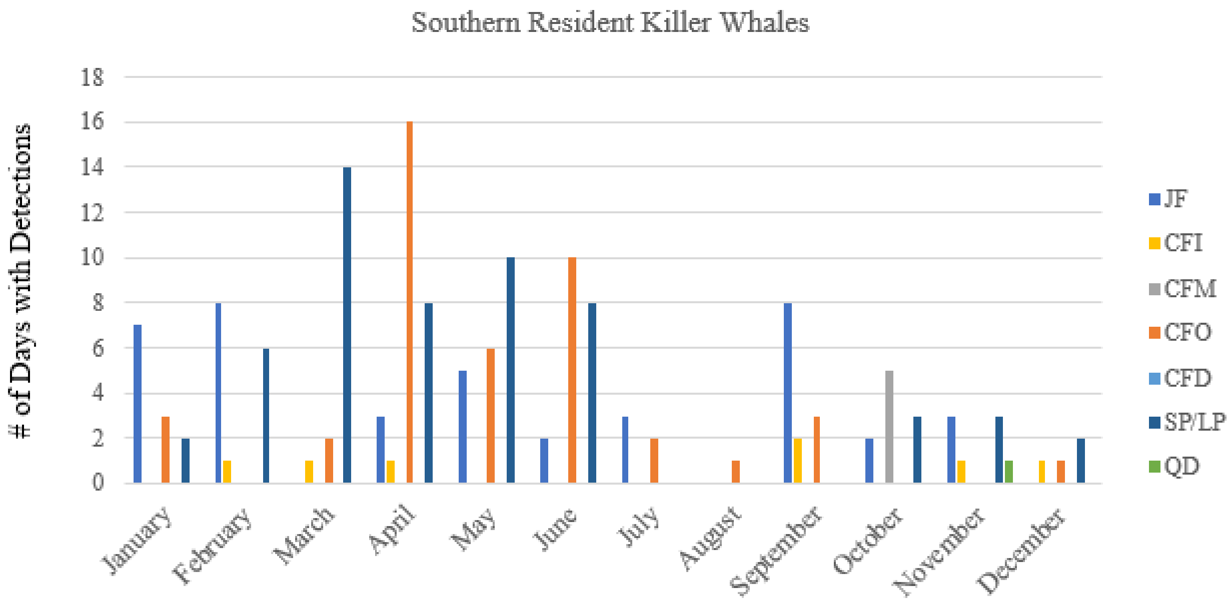

Figure 11. Counts of detections at each northern recorder site by month from 2014-2017 (Emmons et al. 2019). Areas include Juan de Fuca (JF); Cape Flattery Inshore (CFI); Cape Flattery Mid Shelf (CFM); Cape Flattery Offshelf (CFO); Cape Flattery Deep (CFD); Sand Point and La Push (SP/LP); and Quinault Deep (QD).

Additionally, researchers collected data using an autonomous acoustic recorder deployed at Swiftsure Bank from August 2009 to July 2011 to assess how this area is used by Northern Resident and Southern Residents as shown in Figure 12 (Riera et al. 2019). SRKW were detected on 163 days with 175 encounters (see Figure 14 for number of days of acoustic detections for each month). All three pods were detected at least once per month except for J pod in January and November and L pod in March. K and L pods were heard more often (87 percent of calls and 89 percent of calls, respectively), between May and September. J pod was heard most often during winter and spring (76 percent of calls during December and February through May; Riera et al. 2019). K pod had the longest encounters in June, with 87 percent of encounters longer than 2 hours occurring between June and September. L pod had the longest encounters in May, with 79 percent of encounters longer than two hours occurring during the summer (May through September). The longest J pod encounters were during winter, with 72 percent of encounters longer than 2 hours occurring between December and May (Riera et al. 2019).

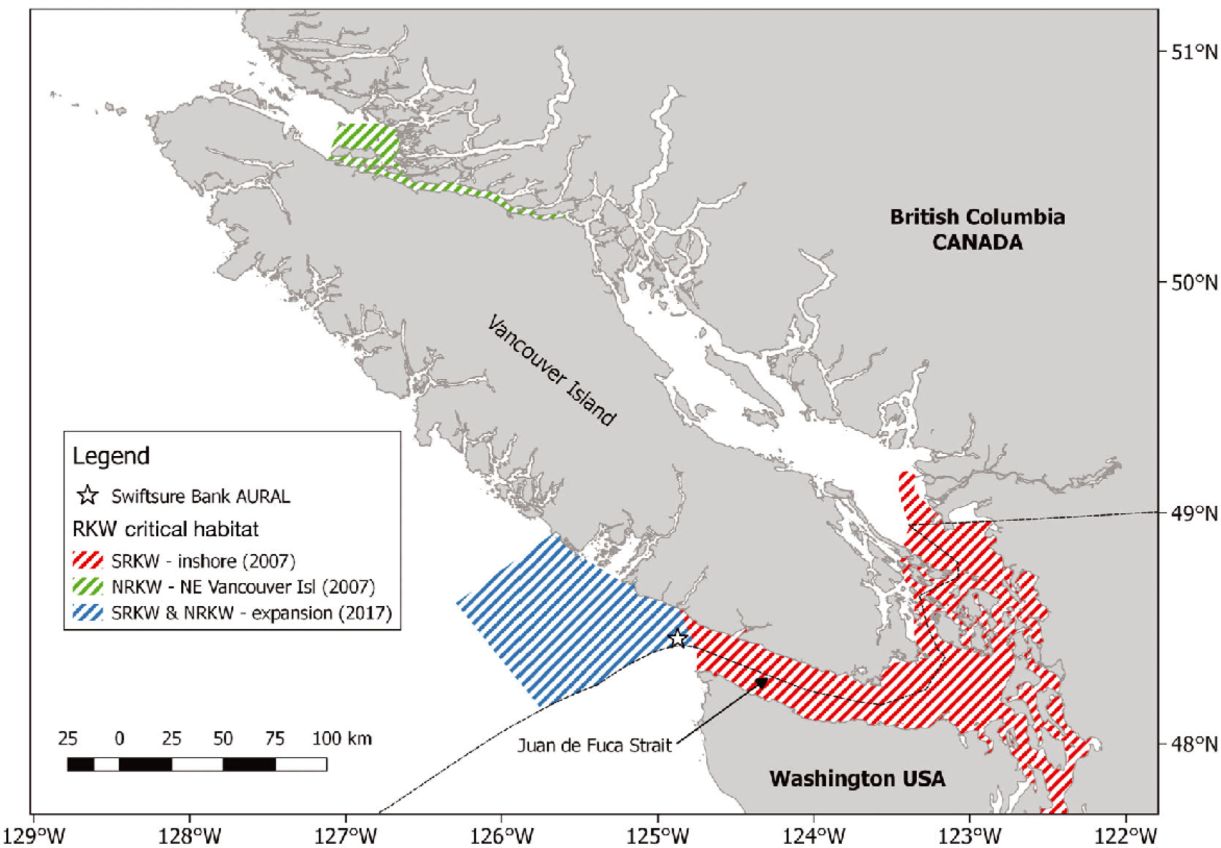

Figure 12. Swiftsure Bank study site off the coast of British Columbia, Canada in relation to the 2007 Northern Resident critical habitat (NE Vancouver Island) and 2007 SRKW critical habitat (inshore waters) and the 2017 Northern Resident and Southern Resident expansion of critical habitat (Riera et al. 2019).

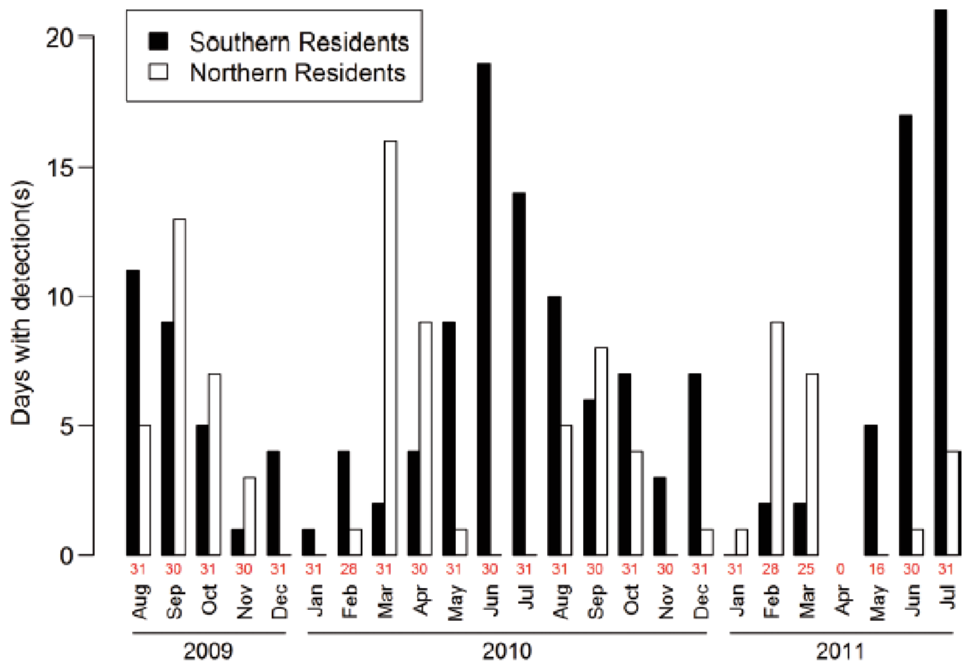

Figure 13. Number of days with acoustic detections of SRKWs at Swiftsure Bank from August 2009–July 2011. Red numbers indicate days of effort. (Riera et al. 2019).

A recent study found SRKWs and NRKWs competition for prey resources among ecologically similar populations that occur in sympatry can be reduced by spatiotemporal resource partitioning and SRKWs were found to prefer the nearshore areas (Emmons et al. 2021). Understanding patterns of habitat use of cetaceans can be difficult since they are highly mobile and can have large home ranges. Passive acoustic monitoring was used at 15 sites along the coast of Washington, to assess habitat use patterns of two sympatric populations, the NRKW and the SRKW. This area is part of the ocean distributions of a number of important runs of Chinook salmon, the preferred prey of both populations, and is proposed critical habitat for SRKW. Monthly occurrences were compared for both populations at recorder locations grouped by their proximity to the Strait of Juan de Fuca to the north and the Columbia River to the south in one analysis and by their distance from shore in a second analysis. NRKW and SRKW were detected throughout the year with spring and fall peaks in occurrence. The northernmost sites accounted for 93 percent of NRKW detections, while less than half of SRKW detections were at these sites. SRKW were most frequently detected at nearshore sites (83 percent of detections), while the majority of NRKW detections were at mid-shelf and deep sites (94 percent of detections) (figure 14). This study provides further information about the habitat use of these resident killer whale populations with implications for their management and conservation.

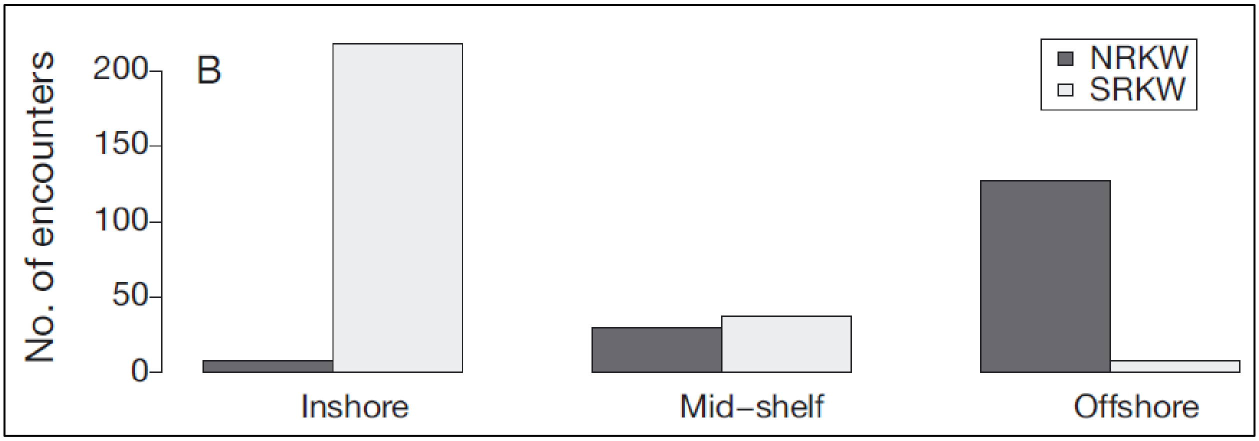

Figure 14. Total number of encounters at inshore, mid-shelf, and offshore sites (Emmons et al. 2021)

Limiting Factors and Threats. Several factors identified in the recovery plan for SRKW may be limiting recovery. The recovery plan identified three major threats including (1) the quantity and quality of prey; (2) toxic chemicals that accumulate in top predators; and (3) impacts from sound and vessels. Oil spills and disease as well as the small population size are also risk factors. It is likely that multiple threats are acting together to impact SRKWs. Modeling exercises have attempted to identify which threats are most significant to survival and recovery (e.g. Lacy et al. 2017) and available data suggest that all of the threats are potential limiting factors (NMFS 2008a).

Quantity and Quality of Prey. SRKWs have been documented to consume a variety of fish species (22 species) and one species of squid (Ford et al. 1998; Ford et al. 2000; Ford and Ellis 2006; Hanson et al. 2010; Ford et al. 2016), but salmon are identified as their primary prey. The best available information suggests an overall preference for Chinook salmon (during the summer and fall. Chum salmon, coho salmon, and steelhead) may also be important in the SRKW diet at particular times and in specific locations. Rockfish (*Sebastes spp*.), Pacific halibut (*Hippoglossus stenolepis*), and Pacific herring (*Clupea pallasi*) were also observed during predation events (Ford and Ellis 2006), however, these data may underestimate the extent of feeding on bottom fish (Baird 2000). A number of smaller flatfish, lingcod (*Ophiodon elongatus*), greenling (*Hexagrammos spp*.), and squid have been identified in stomach content analysis of resident whales (Ford et al. 1998).

SRKWs are the subject of ongoing research, the majority of which has occurred in inland waters of Washington State and British Columbia, Canada during summer months and includes direct observation, scale and tissue sampling of prey remains, and fecal sampling. The diet data suggest that SRKWs are consuming mostly larger (i.e., generally age 3 and up) Chinook salmon (Ford and Ellis 2006). Chinook salmon is their primary prey despite the much lower abundance in comparison to other salmonids in some areas and during certain time periods (Ford and Ellis 2006). Factors of potential importance include the species' large size, high fat and energy content, and year-round occurrence in the SRKW's geographic range. Chinook salmon have the highest value of total energy content compared to other salmonids because of their larger body size and higher energy density (kilocalorie/kilogram (kcal/kg)) (O'Neill et al. 2014). For example, in order for a SRKW to obtain the total energy value of one adult Chinook salmon, they would need to consume approximately 2.7 coho, 3.1 chum, 3.1 sockeye, or 6.4 pink salmon (O'Neill et al. 2014). Research suggests that SRKWs are capable of detecting, localizing, and recognizing Chinook salmon through their ability to distinguish Chinook salmon echo structure as different from other salmon (Au et al. 2010). The degree to which killer whales are able to or willing to switch to non-preferred prey sources (i.e., prey other than Chinook salmon) is also largely unknown, and likely variable depending on the time and location.

Recent stable isotope analyses of opportunistically collected scale samples (Warlick et al. 2020) continue to support and validate previous diet studies (Ford et al. 2016) and what is known of SRKW seasonal movements (Olson et al. 2018, see below), but highlight temporal variability in isotopic values. Warlick et al. (2020) continued to find that Chinook salmon is the primary prey for all pods in summer months followed by coho and then other salmonids. Carbon signatures in samples varied by month, which could indicate variation in Chinook and coho salmon consumption between months and/or differences in carbon signatures across salmon runs and life histories. Peaks in carbon signatures in samples varied between K/L pod and J pod. Though Chinook salmon was the primary prey across years, there was inter-annual variability in nitrogen signature in samples, which could indicate variation in Chinook salmon nitrogen content from year to year or greater Chinook salmon consumption in certain years versus others and/or nutritional stress in certain years, but this is difficult to determine.

Over the last forty years, predation on Chinook salmon off the West Coast of North America by marine mammals has been estimated to have more than doubled (Chasco et al. 2017). In particular, southern Chinook salmon stocks ranging south from the Columbia River have been subject to the largest increases in predation, and Chasco et al. (2017) suggested that SRKWs may be the most disadvantaged compared to other more NRKW populations given the northern migrations of Chinook salmon stocks in the ocean and this competition may be limiting the growth of the SRKW population.

May–September

Scale and tissue sampling from May to September in inland waters of Washington and British Columbia, Canada indicate that the SRKW’s diet consists of a high percentage of Chinook salmon (monthly proportions as high as >90 percent) (Hanson et al. 2010; Ford et al. 2016). Genetic analysis of the Hanson et al. (2010) samples from 2006-2010 indicate that when SRKW are in inland waters from May to September, they primarily consume Chinook salmon stocks that originate from the Fraser River (80–90 percent of the diet in the Strait of Juan de Fuca and San Juan Islands; including Upper Fraser, Mid Fraser, Lower Fraser, North Thompson, South Thompson and Lower Thompson), and to a lesser extent consume stocks from Puget Sound (North and South Puget Sound) and Central British Columbia Coast and West and East Vancouver Island. This is not unexpected as all of these stocks are returning to streams proximal to these inland waters during this timeframe. Few diet samples have been collected in summer months outside of the Salish Sea.

DNA quantification methods are also used to estimate the proportion of different prey species in the diet from fecal samples (Deagle et al. 2005). Recently, Ford et al. (2016) confirmed the importance of Chinook salmon to SRKWs in the early to mid-summer months (May–August) using DNA sequencing from SRKW feces collected in inland waters of Washington and British Columbia. Salmon and steelhead made up greater than 98 percent of the inferred diet, of which almost 80 percent were Chinook salmon. Coho salmon and steelhead are also found in the diet in inland waters of Washington and British Columbia in spring and fall months when Chinook salmon are less abundant. Specifically, coho salmon contribute to over 40 percent of the diet in September in inland waters, which is evidence of prey shifting at the end of summer towards coho salmon (Ford et al. 1998; Ford and Ellis 2006; Hanson et al. 2010; Ford et al. 2016). Less than 3 percent each of chum salmon, sockeye salmon, and steelhead were observed in fecal DNA samples collected in the summer months (May through September) in inland waters.

October–December

Prey remains and fecal samples collected in U.S. inland waters during October through December indicate Chinook and chum salmon are primary contributors of the whale's diet during this time (NWFSC unpublished data). Diet data for the Strait of Georgia and coastal waters is limited.

January–April

Observations of SRKWs overlapping with salmon runs (Wiles 2004; Zamon et al. 2007) and collection of prey and fecal samples have also occurred in coastal waters in the winter and spring months. Although fewer predation events have been observed and fewer fecal samples collected in coastal waters, recent data indicate that salmon, and Chinook salmon in particular, remains an important dietary component when the SRKWs occur in outer coastal waters during these timeframes. Prior to 2013, only three prey samples for SRKW on the U.S. outer coast had been collected (Hanson 2021). From 2013 to 2016, satellite tags were used to locate and follow the whales to obtain predation and fecal samples. A total of 57 samples were collected from northern California to northern Washington (Figure 15). Results of the 57 available prey samples indicate that, as is the case in inland waters, Chinook salmon are the primary species detected in diet samples on the outer coast, although steelhead, chum salmon, lingcod, and halibut were also detected in samples. Despite J pod utilizing much of the Salish Sea—including the Strait of Georgia—in winter months (Hanson et al. 2018), few diet samples have been collected in this region in winter.

The occurrence of K and L pods off the Columbia River in March suggests the importance of Columbia River spring runs of Chinook salmon in their diet (Hanson et al. 2013). Chinook genetic stock identification from samples collected in winter and spring in coastal waters from California through Washington included 12 U.S. west coast stocks, and showed that over half the Chinook salmon consumed originated in the Columbia River (Hanson 2021). Columbia River, Central Valley, Puget Sound, and Fraser River Chinook salmon collectively comprised over 90 percent of the 33 Chinook salmon prey samples collected (for which genetic stock origin was determined, of a total 44 prey samples collected) for SRKWs in coastal areas.

As noted, most of the Chinook salmon prey samples opportunistically collected in coastal waters were determined to have originated from the Columbia River basin, including Lower Columbia Spring, Middle Columbia Tule, and Upper Columbia Summer/Fall. In general, we would expect to find these stocks given the diet sample locations (Figure 15). However, the Chinook salmon stocks included fish from as far north as the Taku River (Alaska and British Columbia stocks) and as far south as the Central Valley California (Hanson et al. 2021).

In an effort to prioritize recovery efforts such as habitat restoration and help inform efforts to use fish hatcheries to increase the whales' prey base, NMFS and WDFW developed a report identifying Chinook salmon stocks thought to be of high importance to SRKW along the West Coast (NOAA and WDFW 2018).[48] Scientists and managers from the U.S. and Canada reviewed the model at a workshop sponsored by the National Fish and Wildlife Foundation (NFWF), where the focus was on assisting NFWF in prioritizing funding for salmon related projects. The priority stock report was created using observations of Chinook salmon stocks found in scat and prey scale/tissue samples, and by estimating the spatial and temporal overlap with Chinook salmon stocks ranging from SEAK to California (CA). Puget Sound Chinook salmon are considered a top priority prey stock. Extra weight was given to the salmon runs that support the Southern Residents during times of the year when the whales' body condition is more likely reduced and when Chinook salmon may be less available, such as in winter months. However, it important to note, this priority stock report will continue to get updated over time as new data become available. Given this was designed to prioritize recovery actions and there are no abundance estimates for each stock that are factored in, it is currently not designed to assess fisheries actions or prey availability by area.

Hatchery production is a significant component of the salmon prey base returning to watersheds within the range of SRKWs (Barnett-Johnson et al. 2007; NMFS 2008a). The release of hatchery fish has not been identified as a threat to the survival or persistence of SRKWs and there is no evidence to suggest the whales prefer wild salmon over hatchery salmon. Increased Chinook salmon abundance, including hatchery fish, benefit this endangered population of whales by enhancing prey availability to SRKWs and hatchery fish often contribute significantly to the salmon stocks consumed (Hanson et al. 2010, Hanson 2021). Currently, hatchery fish play a mitigation role of helping sustain Chinook salmon numbers while other, longer term, recovery actions for natural fish are underway. Although hatchery production has contributed some offset of the historical declines in the abundance of natural-origin salmon within the range of the whales, hatcheries also pose risks to natural-origin salmon populations (Nickelson et al. 1986; Ford 2002; Levin and Williams 2002; Naish et al. 2007). Healthy natural-origin salmon populations are important to the long-term maintenance of prey populations available to Southern Residents because it is uncertain whether a hatchery dominated mix of stocks is sustainable indefinitely and because hatchery fish can differ, relative to natural-origin Chinook salmon, for example, in size and hence caloric value and in availability/migration location and timing.

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[48]https://www.westcoast.fisheries.noaa.gov/publications/protected_species/marine_mammals/killer_whales/recovery/srkw_priority_chinook_stocks_conceptual_model_report___list_22june2018.pdf

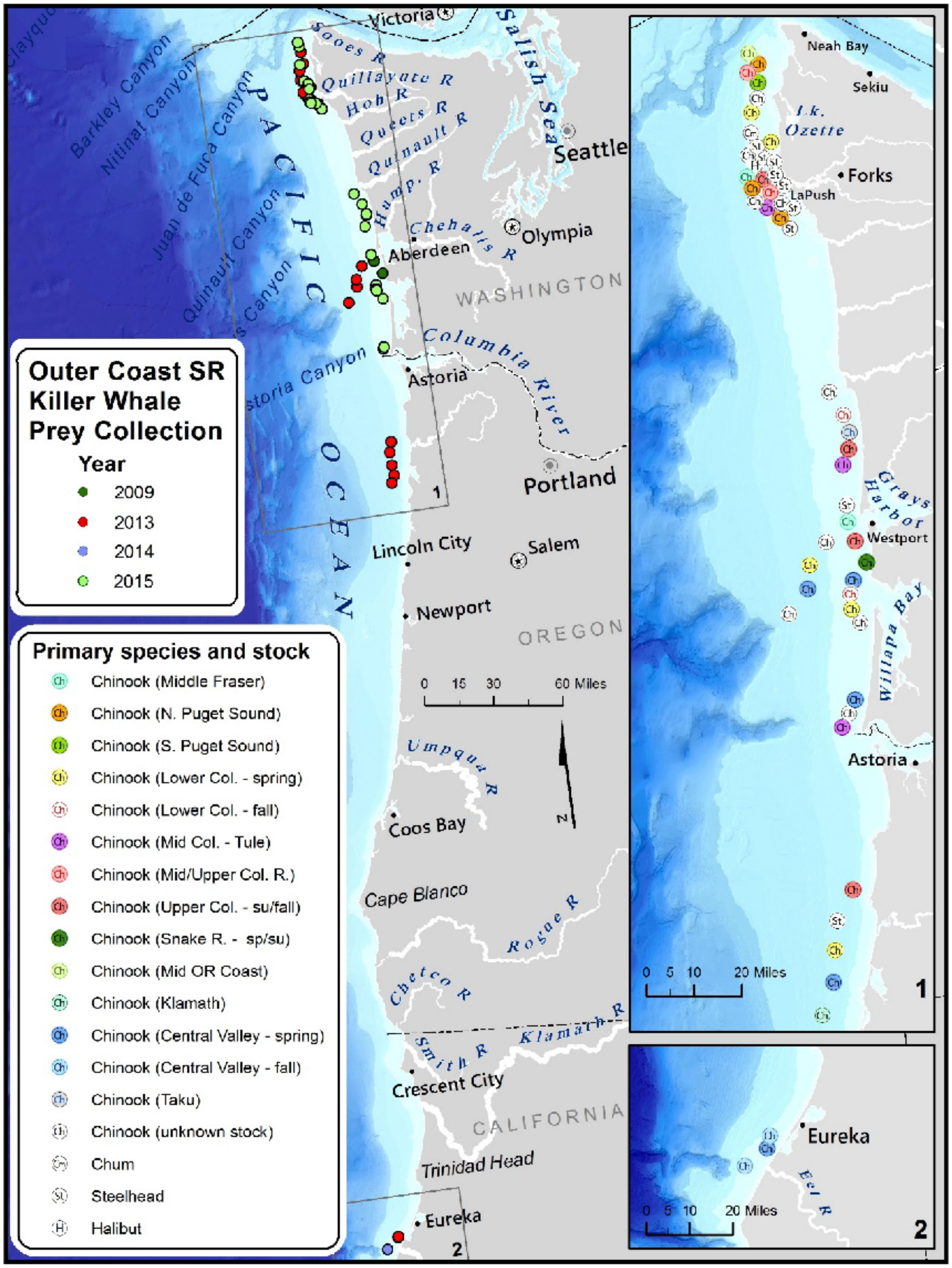

Figure 15. Location and species for scale/tissue samples collected from SRKW predation events in outer coastal waters (NMFS 2019b).

Nutritional Limitation and Body Condition. When prey is scarce or in low density, SRKWs likely spend more time foraging than when prey is plentiful or in high density. Increased energy expenditure and prey limitation can cause poor body condition and nutritional stress. Nutritional stress is the condition of being unable to acquire adequate energy and nutrients from prey resources and as a chronic condition, can lead to reduced body size of individuals and to lower reproductive or survival rates in a population (Trites and Donnelly 2003). During periods of nutritional stress and poor body condition, cetaceans lose adipose tissue behind the cranium, displaying a condition known as "peanut-head" in extreme cases (Pettis et al. 2004; Bradford et al. 2012; Joblon et al. 2014). Between 1994 and 2008, 13 SRKWs were observed from boats to have a pronounced "peanut-head"; and all but two subsequently died (Durban et al. 2009; Center for Whale Research unpublished data). None of the whales that died were subsequently recovered, and therefore definitive cause of death could not be identified. Both females and males across a range of ages were found in poor body condition.

Since 2008, NOAA's Southwest Fisheries Science Center (SWFSC) has used aerial photogrammetry to assess the body condition and health of SRKWs, initially in collaboration with the Center for Whale Research and the Vancouver Aquarium. Aerial photogrammetry studies have provided finer resolution for detecting poor condition, even before it manifests in "peanut-head" that is observable from boats. Annual aerial surveys of the population from 2013-2017 (with exception of 2014) have detected declines in condition before the death of seven SRKWs (L52 and J8 as reported in Fearnbach et al. (2018); J14, J2, J28, J54, and J52 as reported in Durban et al. (2017)), including five of the six most recent mortalities (Trites and Rosen 2018). These data have provided evidence of a general decline in SRKW body condition since 2008, and documented members of J pod being in poorer body condition in May compared to September of the previous year (at least in 2016 and 2017) (Trites and Rosen 2018). Other pods could not be reliably photographed in both seasonal periods.

Data collected from three SRKW strandings in recent years have also contributed to our knowledge of the health of the population and the impact of the threats to which they are exposed. Transboundary partnerships have supported thorough necropsies of L112 in 2012, J32 in 2014, and L95 in 2016, which included testing for contaminant load, disease and pathogens, organ condition, and diet composition.[49] In fall 2016 another young adult male, J34, was found dead in the northern Georgia Strait (Carretta et al. 2021). The necropsy indicated that the whale died of blunt force trauma consistent with vessel strike.

Previous scientific review investigating nutritional stress as a cause of poor body condition for SRKWs concluded "Unless a large fraction of the population experienced poor condition in a particular year, and there was ancillary information suggesting a shortage of prey in that same year, malnutrition remains only one of several possible causes of poor condition" (Hilborn et al. 2012). Body condition in whales can be influenced by a number of factors, including prey availability or limitation, increased energy demands, disease, physiological or life history status, and variability over seasons or across years. Body condition data collected to date has

[49] Reports for those necropsies are available at: http://www.westcoast.fisheries.noaa.gov/protected_species/marine_mammals/killer_whale/rpi_strandings.html

documented declines in condition for some animals in some pods and these occurrences have been scattered across demographic and social groups (Fearnbach et al. 2018).

It is possible that poor nutrition could contribute to mortality through a variety of mechanisms. To exhibit how this is possible, we reference studies that have demonstrated the effects of energetic stress (caused by incremental increases in energy expenditures or incremental reductions in available energy) on adult females and juveniles, which have been studied extensively (e.g., adult females: Gamel et al. 2005), Schaefer 1996, Daan et al. 1996, juveniles: Trites and Donnelly 2003). Small, incremental increases in energy demands should have the same effect on an animal's energy budget as small, incremental reductions in available energy, such as one would expect from reductions in prey. Malnutrition and persistent or chronic stress can induce changes in immune function in mammals and may be associated with increased bacterial and viral infections, and lymphoid depletion (Mongillo et al. 2016; Neale et al. 2005; Maggini et al. 2018). Ford and Ellis (2006) report that SRKWs engage in prey sharing about 76 percent of the time. Prey sharing presumably would distribute more evenly the effects of prey limitation across individuals of the population than would otherwise be the case (i.e., if the most successful foragers did not share with other individuals).

Evidence of reduced growth and poor survival in SRKW and NRKW populations at a time when Chinook salmon abundance was low suggests that low abundance may have contributed to nutritional deficiency with serious effects on individual whales. Reduced body condition and body size has been observed in SRKW and NRKW populations. For example, Groskreutz et al. (2019) used aerial photogrammetry to measure growth and length in adult NRKW, which prey on similar runs of Chinook salmon, from 2014 to 2017. Given that killer whales physically mature at age 20 and the body stops growing (Noren 2011), we would expect adult male killer whales to all have similar body lengths and all adult female killer whales to have similar body lengths. However, Groskreutz et al. (2019) found adult whales that were 20 – 40 years old have significantly shorter body lengths than those older than 40 years of age, suggesting the younger mature adults had experienced inhibited growth. Similarly, adult Southern Residents under 30 years of age that were measured in 2008 by the same photogrammetric technique were also shorter on average than older individuals also suggesting reduced growth (Fearnbach et al. 2011).

What appears to be constrained growth in both resident killer whale populations occurred in the 1990s during a time when range-wide abundance of Chinook salmon in multiple subsequent years fell below the 1979–2003 average (Ford et al. 2010). The low Chinook salmon abundance and smaller growth in body size in whales coincided with an almost 20 percent decline from 1995 to 2001 (from 98 whales to 81 whales) in the SRKW population (NMFS 2008g). During this period of decline, multiple deaths occurred in all three pods of the SRKW population and relatively poor survival occurred in nearly all age classes and in both males and females. The NRKWs also experienced population declines during the late 1990s and early 2000s. Hilborn et al. (2012) stated that periods of decline across killer whale populations "suggest a likely common causal factor influencing their population demographics" (Hilborn et al. 2012).

During this same general period of time of low Chinook salmon abundance, declining body size in whales, and declining resident killer whale populations, all three SRKW pods experienced substantially low social cohesion (Parsons et al. 2009). This temporal shift in SRKW social cohesion may reflect a response to changes in prey. (Foster et al. 2012) similarly found a significant correlation between SRKW social network connectivity and Chinook salmon prey abundance for the years 1984-2007, where in years with higher Chinook salmon abundance, SRKW social network was more interconnected. The authors discuss that because of this result, years with higher Chinook salmon abundance may lead to more opportunities for mating and information transfer between individuals.

Although both intrinsic and extrinsic factors can affect social cohesion, it has been generally recognized the most important extrinsic factors for medium and larger terrestrial carnivores are the distribution and abundance of prey (refer to Parsons et al. 2009). In social animals, once optimal group size occurs (that is based on intrinsic and extrinsic factors), the response to reduced prey abundance for example could include "group fissioning". However, this may not always be the case, especially if the benefit of "cooperative care" or food sharing outweighs the cost of the large group size. Parsons et al. (2009) note that smaller divisions within the pod's matrilines may temporarily occur in SRKWs as opposed to true fission but this warrants further investigation. Good fitness and body condition coupled with stable group cohesion and reproductive opportunities are important for reproductive success.

<u>Toxic Chemicals.</u> Various adverse health effects in humans, laboratory animals, and wildlife have been associated with exposures to persistent pollutants. These pollutants have the ability to cause endocrine disruption, reproductive disruption or failure, immunotoxicity, neurotoxicity, neurobehavioral disruption, and cancer (Reijnders 1986; Subramanian et al. 1987; de Swart et al. 1996; Bonefeld-Jørgensen et al. 2001; Reddy et al. 2001; Schwacke et al. 2002; Darnerud 2003; Legler and Brouwer 2003; Viberg et al. 2003; Ylitalo et al. 2005; Fonnum et al. 2006; Darnerud 2008; Legler 2008). SRKWs are exposed to a mixture of pollutants, some of which may interact synergistically and enhance toxicity, influencing their health, and reproduction. Relatively high levels of these pollutants have been measured in blubber biopsy samples from SRKWs compared to other resident killer whales in the North Pacific (Ross et al. 2000; Krahn et al. 2007; Krahn et al. 2009; Lawson et al. 2020), and more recently, these pollutants were measured in fecal samples collected from SRKWs providing another potential opportunity to evaluate exposure to these pollutants (Lundin et al. 2016a; Lundin et al. 2016b).

SRKWs are exposed to persistent pollutants primarily through their diet. For example, Chinook salmon contain higher levels of some persistent pollutants than other salmon species when comparing the limited information available for pollutant levels in Chinook salmon (Krahn et al. 2007; O'Neill and West 2009; Veldhoen et al. 2010; Mongillo et al. 2016). These harmful pollutants, through consumption of prey species that contain these pollutants, are stored in the blubber and can later be released; when the pollutants are released, they are redistributed to other tissues when the SRKWs metabolize the blubber, for example, responses to food shortages or reduced acquisition of food energy as one possible stressor. The release of pollutants can also occur during gestation or lactation. Once the pollutants mobilize from the blubber in to circulation, they have the potential to cause a toxic response. Therefore, nutritional stress from reduced Chinook salmon populations may act synergistically with high pollutant levels in SRKWs and result in adverse health effects.

In April 2015, NMFS hosted a 2-day SRKW health workshop to assess the causes of decreased survival and reproduction in the killer whales. Following the workshop, a list of potential action items to better understand what is causing decreased reproduction and increased mortality in this population was generated and then reviewed and prioritized to produce the Priorities Report (NMFS 2015c). The report also provides prioritized opportunities to establish important baseline information on Southern Resident and reference populations to better assess negative impacts of future health risks, as well as positive impacts of mitigation strategies on SRKW health.

Disturbance from Vessels and Sound. Killer whales rely on their highly developed acoustic sensory system for navigating, locating prey, and communicating with other individuals. While in inland waters of Washington and British Columbia, SRKWs are the principal target species for the commercial whale watch industry (Hoyt 2001; O'Connor et al. 2009) and encounter a variety of other vessels in their urban environment (e.g., recreational, fishing, ferries, military, shipping). Several main threats from vessels include direct vessel strikes (which can result in injury or mortality (Gaydos and Raverty 2007)), the masking of echolocation and communication signals by anthropogenic sound, and behavioral changes (NMFS 2008a). There is a growing body of evidence documenting effects from vessels on small cetaceans and other marine mammals. Research has shown that SRKWs spend more time traveling and performing surface active behaviors and less time foraging in the presence of all vessel types, including kayaks, and that noise from motoring vessels up to 400 meters away has the potential to affect the echolocation abilities of foraging whales (Holt 2008; Lusseau et al. 2009; Noren et al. 2009; Williams et al. 2010). Individual energy balance may be impacted when vessels are present because of the combined increase in energetic costs resulting from changes in whale activity with the decrease in prey consumption resulting from reduced foraging opportunities (Williams et al. 2006; Lusseau et al. 2009; Noren et al. 2009; Noren et al. 2012). Ayres et al. (2012) examined glucocorticoid and thyroid hormone levels in fecal samples collected from SRKWs in inland waters and their results suggest that the impacts from vessel traffic on hormone levels are lower than the impacts from reduced prey availability. In another study, suction-cup sound and movement tags were attached to SRKWs in their summer habitat while collecting geo-referenced proximate vessel data. Holt et al. (2021a) identified prey capture dives by using whale kinematic signatures and it found that the probability of capturing prey increased as salmon abundance increased but decreased as vessel speed increased. When vessels emitted navigational sonar, whales made longer dives to capture prey and descended more slowly when they initiated these dives. Finally, whales descended more quickly when noise levels were higher and vessel approaches were closer.

At the time of the SRKWs' listing under the ESA, NMFS reviewed existing protections for the whales and developed recovery actions, including vessel regulations, to address the threat of vessels to SRKWs. NMFS concluded it was necessary and advisable to adopt regulations to protect SRKWs from disturbance and sound associated with vessels, to support recovery of SRKWs. Federal vessel regulations were established in 2011 to prohibit vessels from approaching SRKWs within 200 yards (182.9m) and from parking in the path of SRKWs within 400 yards (365.8m). These regulations apply to all vessels in inland waters of Washington State with exemptions to maintain safe navigation and for government vessels in the course of official duties, ships in the shipping lanes, research vessels under permit, and vessels lawfully engaged in commercial or treaty Indian fishing that are actively setting, retrieving, or closely tending fishing gear (76 FR 20870, April, 14, 2011).

In 2019, the Washington Legislature passed Senate Bill 5577: a bill concerning the protection of SRKWs from vessels, which developed a license for commercial whale watching and directed the WDFW to administer the licensing program and develop rules for commercial viewing of SRKW. *See* RCW 77.65.615 and RCW 77.65.620. In 2021 the rule went into effect. The rules do not restrict the viewing of other whales or marine mammals, but set a three-month July-September season for viewing of SRKW by motorized commercial whale watching vessels at closer than one-half nautical mile. From July-September, motorized commercial whale watching of SRKWs is permitted daily during two, two-hour periods (10 a.m-12 p.m. and 3-5 p.m.). During these times, there is a limit of three motorized commercial whale watching vessels per group of SRKWs. The rules formally establish the 'no-go' zone on the west side of San Juan Island for motorized commercial whale watching vessels, allowing a 100-yard corridor along the shore for commercial kayak tours. The no-go zone applies year-round regardless of SRKW presence. The no-go zone remains voluntary for vessels not engaging in commercial whale watching operations. The rules establish training, reporting, and compliance monitoring procedures, including real-time reporting of SRKW sightings to the Whale Report Alert System.

In the final rule implementing these regulations, NMFS committed to reviewing the vessel regulations to evaluate effectiveness, and also to study the impact of the regulations on the viability of the local whale watch industry. In December 2017, NMFS completed a technical memorandum evaluating the effectiveness of regulations adopted in 2011 to help protect endangered SRKWs from the impacts of vessel traffic and noise (Ferrara et al. 2017). In the assessment, Ferrara et al. (2017) used five measures: education and outreach efforts, enforcement, vessel compliance, biological effectiveness, and economic impacts. For each measure, the trends and observations in the five years leading up to the regulations (2006-2010) were compared to the trends and observations in the five years following the regulations (2011-2015). The memo finds that some indicators suggested the regulations have benefited SRKWs by reducing impacts without causing economic harm to the commercial whale-watching industry or local communities, whereas some indicators suggested that vessel impacts continue and that some risks may have increased. The authors also found room for improvement in terms of increasing awareness and enforcement of the regulations, which would help improve compliance and further reduce biological impacts to the whales.

In addition to vessels, underwater sound can be generated by a variety of other human activities, such as dredging, drilling, construction, seismic testing, and sonar (Richardson et al. 1995; Gordon and Moscrop. 1996; National Research Council 2003). Impacts from these sources can range from serious injury and mortality to changes in behavior. In other cetaceans, hormonal changes indicative of stress have been recorded in response to intense sound exposure (Romano et al. 2003). Chronic stress is known to induce harmful physiological conditions including lowered immune function, in terrestrial mammals and likely does so in cetaceans (Gordon and Moscrop. 1996).

Oil Spills. In the Northwest, SRKWs are the most vulnerable marine mammal population to the risks imposed by an oil spill due to their small population size, strong site fidelity to areas with high oil spill risk, large pod size, late reproductive maturity, low reproductive rate, and specialized diet, among other attributes (Jarvela-Rosenberger et al. 2017). Oil spills have occurred in the range of SRKWs in the past, and there is potential for spills in the future. Oil can be discharged into the marine environment in any number of ways, including shipping accidents, refineries and associated production facilities, and pipelines. Despite many improvements in spill prevention since the late 1980s, much of the region inhabited by SRKWs remains at risk from serious spills because of the heavy volume of shipping traffic and proximity to petroleum refining centers.

Repeated ingestion of petroleum hydrocarbons by killer whales likely causes adverse effects; however, long-term consequences are poorly understood. In marine mammals, acute exposure to petroleum products can cause changes in behavior and reduced activity, inflammation of the mucous membranes, lung congestion and disease, pneumonia, liver disorders, neurological damage, adrenal toxicity, reduced reproductive rates, and changes in immune function (Schwacke et al. 2013; Venn-Watson et al. 2015; de Guise et al. 2017; Kellar et al. 2017), potentially death and long-term effects on population viability (Matkin et al. 2008; Ziccardi et al. 2015). For example, 122 cetaceans stranded or were reported dead within 5 months following the Deepwater Horizon spill in the Gulf of Mexico (Ziccardi et al. 2015). An additional 785 cetaceans were found stranded from November 2010 to June 2013, which was declared an unusual mortality event (Ziccardi et al. 2015). Previous polycyclic aromatic hydrocarbons (PAH) exposure estimates suggested SRKWs can be occasionally exposed to concerning levels (Lachmuth et al. 2011). More recently, Lundin et al. (2018) measured PAHs in whale fecal samples collected in inland waters of Washington between 2010 and 2013 and found low concentrations of the measured PAHs (<10 parts per billion (ppb), wet weight). However, PAHs were as high as 104 ppb in the first year of their study (2010) compared to the subsequent years. Although it is unclear the cause of this trend, higher levels were observed prior to the 2011 vessel regulations that increased the distance vessels could approach the whales. In addition, oil spills have the potential to adversely impact habitat and prey populations, and, therefore, may adversely affect SRKWs by reducing food availability.

<u>Climate Change and Other Ecosystem Effects.</u> In Section 2.2, above, we briefly discussed climate change and the stress it can bring to the ESA-listed species and habitats considered in this Opinion. In a broader view, overwhelming data indicate the planet is warming (IPCC 2014), which poses a threat to many species. Climate change has the potential to impact species abundance, geographic distribution, migration patterns, timing of seasonal activities (IPCC 2014), and species viability into the future. Changes in climate and ocean conditions happen on several different time scales and have had a profound influence on distributions and abundances of marine and anadromous fishes.

Climate change is expected to impact anadromous fish during all stages of their complex life cycle. In addition to the direct effects of rising temperatures, indirect effects include alterations in stream flow patterns in freshwater and changes to food webs in freshwater, estuarine and marine habitats. There is high certainty that predicted physical and chemical changes will occur; however, the ability to predict biological changes to fish or food webs in response to these physical/chemical changes is extremely limited, leading to considerable uncertainty.

Pacific Northwest anadromous fish inhabit as many as three marine ecosystems during their ocean residence period: the Salish Sea, the California Current, and the Gulf of Alaska (Brodeur et al. 1992; Weitkamp and Neely 2002; Morris et al. 2007). The response of these ecosystems to climate change is expected to differ, although there is considerable uncertainty in all predictions. Columbia River and Puget Sound anadromous fish also use coastal areas of British Columbia and Alaska, and mid-ocean habitats in the Gulf of Alaska, although their fine-scale distribution and marine ecology during this period are poorly understood (Morris et al. 2007; Pearcy and McKinnell 2007). Increases in temperature in Alaskan marine waters have generally been associated with increases in productivity and salmon survival (Mantua et al. 1997; Martins et al. 2012).

Warmer streams, loss of coastal habitat due to sea level rise, ocean acidification, lower summer stream flows, higher winter stream flows, and changes in water quality and freshwater inputs are projected to negatively affect salmon (e.g. Mauger et al. 2015). The persistence of cold water "refugia" within rivers and the diversity among salmon populations will be critical in helping salmon populations adapt to future climate conditions. More detailed discussions about the likely effects from climate change in freshwater systems on salmonids can be found in biological opinions such as the implementation of the Mitchell Act (NMFS 2017b).

In marine waters, increasing temperatures are associated with observed and predicted poleward range expansions of fish and invertebrates in both the Atlantic and Pacific oceans (Lucey and Nye 2010; Asch 2015; Cheung et al. 2015). Rapid poleward species shifts in distribution in response to anomalously warm ocean temperatures have been well documented in recent years, confirming this expectation at short time scales. Range extensions were documented in many species from southern California to Alaska during unusually warm water associated with "the blob" in 2014 and 2015 (Bond et al. 2015; Di Lorenzo and Mantua 2016), and past strong El Nino events (Pearcy 2002; Fisher et al. 2015).

The potential impacts of climate and oceanographic change on whales and other marine mammals will likely involve effects on habitat availability and food availability. For species that depend on salmon for prey, such as SRKWs, the fluctuations in salmon survival that occur with these changes in climate conditions can have negative effects. Site selection for migration, feeding, and breeding may be influenced by factors such as ocean currents and water temperature. For example, there is some evidence from Pacific equatorial waters that sperm whale feeding success and, in turn, calf production rates are negatively affected by increases in sea surface temperature (Smith and Whitehead 1993; Whitehead 1997). Different species of marine mammals will likely react to these changes differently. MacLeod (2009) estimated, based on expected shifts in water temperature, 88 percent of cetaceans would be affected by climate change, with 47 percent likely to be negatively affected. Range size, location, and whether or not specific range areas are used for different life history activities (e.g. feeding, breeding) are likely to affect how each species responds to climate change (Learmonth et al. 2007).

Although few predictions of impacts on the Southern Residents have been made, it seems likely that any changes in weather and oceanographic conditions resulting in effects on salmon populations would have consequences for the whales. SRKWs might shift their distribution in response to climate-related changes in their salmon prey. Persistent pollutant bioaccumulation may also change because of changes in the food web.

Recent analysis ranked the vulnerability of West Coast salmon stocks to climate change and, of the top priority stocks for Southern Residents (NMFS and WDFW 2018), California Central Valley Chinook salmon stocks, Snake river fall and spring/summer Chinook salmon, Puget Sound Chinook salmon, and spring-run Chinook salmon stocks in the interior Columbia and Willamette River basins were ranked as "high" or "very high" vulnerability to climate change (Crozier et al. 2019). In general, Chinook, coho, and sockeye salmon runs were more vulnerable and this stemmed from exposure to higher ocean and river temperatures as well as exposure to changes in flow regimes (including in relation to snowpack, upwelling, sea level rise, and flooding). However, certain Chinook salmon runs do have higher ability to adapt and/or cope with climate change due to high life history diversity in juveniles and adults (including both subyearling and yearling smolts, multiple migration timings), but diversity may be lost with future climate change. Overall, chum and pink salmon were less vulnerable to climate change because they spend less time in fresh water than other salmonids, and certain steelhead runs had more moderate vulnerability than many Chinook and coho salmon runs because of higher resilience (Crozier et al. 2019).

2.2.2 Status of the Critical Habitats

This section examines the status of designated critical habitat affected by the proposed action by examining the condition and trends of essential physical and biological features throughout the designated areas. These features are essential to the conservation of the listed species because they support one or more of the species' life stages (e.g., sites with conditions that support spawning, rearing, migration and foraging).

Salmon and Steelhead Critical Habitat

For salmon and steelhead, NMFS ranked watersheds within designated critical habitat at the scale of the fifth-field hydrologic unit code (HUC5) in terms of the conservation value they provide to each listed species they support. The conservation rankings are high, medium, or low. To determine the conservation value of each watershed to species viability, NMFS's critical habitat analytical review teams (CHARTs) evaluated the quantity and quality of habitat features (for example, spawning gravels, wood and water condition, side channels), the relationship of the area compared to other areas within the species' range, and the significance to the species of the population occupying that area (NOAA Fisheries 2005). Thus, even a location that has poor quality of habitat could be ranked with a high conservation value if it were essential due to factors such as limited availability (e.g., one of a very few spawning areas), a unique contribution of the population it served (e.g., a population at the extreme end of geographic distribution), or if it serves another important role (e.g., obligate area for migration to upstream spawning areas).

The physical or biological features of freshwater spawning and incubation sites, include water flow, quality and temperature conditions and suitable substrate for spawning and incubation, as well as migratory access for adults and juveniles (Table 12). These features are essential to conservation because without them the species cannot successfully spawn and produce offspring.

The physical or biological features of freshwater migration corridors associated with spawning and incubation sites include water flow, quality and temperature conditions supporting larval and adult mobility, abundant prey items supporting larval feeding after yolk sac depletion, and free passage (no obstructions) for adults and juveniles. These features are essential to conservation because they allow adult fish to swim upstream to reach spawning areas and they allow larval fish to proceed downstream and reach the ocean.

Table 12. PCEs of critical habitats designated for ESA-listed salmon and steelhead species considered in this Opinion and corresponding species life history events.

Primary Constituent Elements Site Type	Primary Constituent Elements Site Attribute	Species Life History Event
Freshwater spawning	Substrate Water quality Water quantity	Adult spawning Embryo incubation Alevin growth and development
Freshwater rearing	Floodplain connectivity Forage Natural cover Water quality Water quantity	Fry emergence from gravel Fry/parr/smolt growth and development
Freshwater migration	Free of artificial obstruction Natural cover Water quality Water quantity	Adult sexual maturation Adult upstream migration and holding Kelt (steelhead) seaward migration Fry/parr/smolt growth, development, and seaward migration
Estuarine areas	Forage Free of artificial obstruction Natural cover Salinity Water quality Water quantity	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 areas	Forage Free of artificial obstruction Natural cover Water quantity Water quality	Adult growth and sexual maturation Adult spawning migration Nearshore juvenile rearing

CHART Salmon and Steelhead Critical Habitat Assessments. The CHART for each recovery domain assessed biological information pertaining to occupied habitat by listed salmon and steelhead, determine whether those areas contained PCEs essential for the conservation of those species and whether unoccupied areas existed within the historical range of the listed salmon and steelhead that are also essential for conservation. The CHARTs assigned a 0 to 3 point score for the PCEs in each HUC_5 watershed for:

Factor 1. Quantity,
Factor 2. Quality—Current Condition,

Factor 3. Quality—Potential Condition,[50]
Factor 4. Support of Rarity Importance,
Factor 5. Support of Abundant Populations, and
Factor 6. Support of Spawning/Rearing.

Thus, the quality of habitat in a given watershed was characterized by the scores for Factor 2 (quality—current condition), which considers the existing condition of the quality of PCEs in the HUC_5 watershed and Factor 3 (quality—potential condition) which considers the likelihood of achieving PCE potential in the HUC_5 watershed, either naturally or through active conservation/restoration, given known limiting factors, likely biophysical responses, and feasibility.

Puget Sound Recovery Domain. Critical habitat has been designated in Puget Sound for PS Chinook salmon, PS steelhead, and HCSR chum salmon. 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 for PS Chinook salmon was designated on September 2, 2005 (70 FR 52630). Critical habitat includes 1,683 miles of streams, 41 square mile of lakes, and 2,182 miles of nearshore marine habitat in Puget Sound. The Puget Sound Chinook salmon ESU has 61 freshwater and 19 marine areas within its range. Of the freshwater watersheds, 41 are rated high conservation value, 12 low conservation value, and eight received a medium rating. Of the marine areas, all 19 are ranked with high conservation value.

Critical habitat for HCSRC was designated on September 2, 2005 (70 FR 52630). Critical habitat includes 79 miles of rivers and 377 miles of nearshore marine habitat in Hood Canal. Most freshwater rivers in HCSRC designated critical habitat are in fair to poor condition (Table 15). Many nearshore areas are degraded, but some areas, including Port Gamble Bay, Port Ludlow, and Kilisut Harbor, remain in good condition (Daubenberger et al 2017, Garono and Robinson. 2002).

Critical habitat for PS steelhead was designated on February 24, 2016 (81 FR 9252). Critical habitat includes 2,031 stream miles. Nearshore and offshore marine waters were not designated for this species. There are 66 watersheds within the range of this DPS. Nine watersheds received a low conservation value rating, 16 received a medium rating, and 41 received a high rating to the DPS. Critical habitat for PS steelhead includes freshwater spawning sites, freshwater rearing sites, and freshwater migration corridors.

Critical habitat is designated for PS Chinook salmon and Hood Canal Summer run chum in estuarine and nearshore areas. PS steelhead move rapidly out of freshwater and into offshore

[50] Definition of "Potential Condition": Considers the likelihood of achieving PCE potential in the HUC5, either naturally or through active conservation/restoration, given known limiting factors, likely biophysical responses, and feasibility

marine areas, unlike Puget Sound Chinook and Hood Canal summer chum, making it difficult to identify specific foraging areas where the essential features are found. We therefore determined that for Puget Sound steelhead it is not possible to identify specific areas with essential features in the nearshore zone in Puget Sound. Designated critical habitat for PS steelhead does not include nearshore areas, as this species does not make extensive use of these areas during the juvenile life stage.

Landslides can occur naturally in steep, forested lands, but inappropriate land use practices likely have accelerated their frequency and the amount of sediment delivered to streams. Fine sediment from unpaved roads has also contributed to stream sedimentation. Unpaved roads are widespread on forested lands in the Puget Sound basin, and to a lesser extent, in rural residential areas. Historical logging removed most of the riparian trees near stream channels. Subsequent agricultural and urban conversion permanently altered riparian vegetation in the river valleys, leaving either no trees, or a thin band of trees. The riparian zones along many agricultural areas are now dominated by alder, invasive canary grass and blackberries, and provide substantially reduced stream shade and large wood recruitment (SSPS 2007).

Diking, agriculture, revetments, railroads and roads in lower stream reaches have caused significant loss of secondary channels in major valley floodplains in this region. Confined main channels create high-energy peak flows that remove smaller substrate particles and large wood. The loss of side-channels, oxbow lakes, and backwater habitats has resulted in a significant loss of juvenile salmonid rearing and refuge habitat. When the water level of Lake Washington was lowered 9 feet in the 1910s, thousands of acres of wetlands along the shoreline of Lake Washington, Lake Sammamish and the Sammamish River corridor were drained and converted to agricultural and urban uses. Wetlands play an important role in hydrologic processes, as they store water that 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 turbidity, 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. 1996). After years of forensic investigation, the urban runoff coho mortality syndrome has now been directly linked to motor vehicle tires, which deposit the compound 6PPD and its abiotic transformation product 6PPD-quinone onto roads. 6PPD or [(N-(1, 3-dimethylbutyl)-N’-phenyl-p-phenylenediamine] is used to preserve the elasticity of tires. 6PPD can transform in the presence of ozone (O3) to 6PPD-quinone. 6PPD-quinone is ubiquitous to roadways (Sutton et al. 2019) and was identified by Tian et al. (2020) as the primary cause of urban runoff coho mortality syndrome described by Scholz et al. (2011). Laboratory studies have demonstrated that juvenile coho salmon (Chow et al. 2019), juvenile steelhead, and juvenile Chinook salmon (J. McIntyre and N. Scholz, unpublished results, 2020) are also susceptible to varying degrees of mortality when exposed to urban stormwater. Fortunately, recent literature has also shown that mortality can be prevented by infiltrating road runoff through soil media containing organic matter, which removes 6PPD-quinone and other contaminants (Fardel et al. 2020; Spromberg et al. 2016; McIntrye et al. 2015). Research and corresponding adaptive management surrounding 6PPD is rapidly evolving. Although Chinook did not experience the same level of mortality, tire leachate is still a concern for all salmonids. Traffic residue also contains many unregulated toxic chemicals such as pharmaceuticals, polycyclic aromatic hydrocarbons (PAHs), fire retardants, and emissions that have been linked to deformities, injury and/or death of salmonids and other fish (Trudeau 2017; Young et al. 2018).

Dams constructed for hydropower generation, irrigation, or flood control have substantially affected PS salmon and steelhead 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 large wood to downstream areas (SSPS 2007). These actions tend to promote downstream channel incision and simplification (Kondolf 1997), limiting fish habitat. Water withdrawals reduce available fish habitat and alter sediment transport. Hydropower projects often change flow rates, stranding and killing fish, and reducing aquatic invertebrate (food source) productivity (Hunter 1992). Juvenile mortality occurs in unscreened or inadequately screened diversions. Water diversion ditches resemble side channels in which juvenile salmonids normally find refuge. When diversion headgates are shut, access back to the main channel is cut off and the channel goes dry. Mortality can also occur with inadequately screened diversions from impingement on the screen, or mutilation in pumps where gaps or oversized screen openings allow juveniles to get into the system (WDFW 2009). 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 nearshore 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 nearshore environment (HCCC 2005; SSPS 2007).

NMFS has completed several section 7 consultations on large-scale habitat projects affecting listed species in Puget Sound. Among these are the Washington State Forest Practices Habitat Conservation Plan (NMFS 2006a), and consultations on Washington State Water Quality Standards (NMFS 2008c), the National Flood Plain Insurance Program (NMFS 2008d), the Washington State Department of Transportation Preservation, Improvement and Maintenance Activities (NMFS 2013a), and the Elwha River Fish Restoration Plan (Ward et al. 2008; NMFS 2014f; 2019f; 2020g).

In 2012, the Puget Sound Action Plan was also developed with several federal agencies (e.g., Environmental Protection Agency, NOAA Fisheries, the Corps of Engineers, Natural Resources Conservation Service, United States Geological Survey, Federal Emergency Management Agency, and US Fish and Wildlife Service) collaborated on an enhanced approach to implement the Puget Sound Action Plan. On January 18, 2017, the National Puget Sound Task Force reviewed and accepted the Interim Draft of the Puget Sound Federal Task Force Action Plan FY 2017-202129. The purpose of the Puget Sound Federal Task Force Action Plan is to contribute toward realizing a shared vision of a healthy and sustainable Puget Sound ecosystem by leveraging Federal programs across agencies and coordinating diverse programs on a specific suite of priorities.

As discussed in the Status section, the abundance of Chinook salmon in recent years is significantly less than historic abundance due to a number of human activities. The most notable human activities that cause adverse effects on ESA-listed and non-ESA-listed salmon include: land use activities that result in habitat loss and degradation, hatchery practices, harvest and hydropower systems.

As mentioned previously, numerous factors have led to the decline of PS Chinook salmon including overharvest, freshwater and marine habitat loss, hydropower development, and hatchery practices, as mentioned in Section 2.2.1, above. Adjustments can, and have been made in the short term to ameliorate some of the factors for decline. Harvest can be adjusted on yearly or even in-season basis. Since PS Chinook salmon were listed, harvest in state and federal fisheries has been reduced in an effort to increase the number of adults returning to spawning grounds. Likewise, hatchery management can, and has been adjusted relatively quickly when practices are detrimental to listed species. To address needed improvements in hydropower, NMFS has issued biological opinions with reasonable and prudent alternatives to improve fish passage at existing hydropower facilities. Unlike the other factors, however, loss of critical habitat quality is much more difficult to address in the short term. Once human development causes loss of critical habitat quality, that loss tends to persist for decades or longer. The condition of critical habitat will improve only through active restoration or natural recovery following the removal of human infrastructure. As noted throughout this Opinion, future effects of climate change on habitat quality throughout Puget Sound are expected to be negative.

Habitat utilization by Chinook and steelhead in the Puget Sound area has been historically limited by large dams and other manmade barriers in a number of drainages, including the

Nooksack, Skagit, White, Nisqually, Skokomish, and Elwha river basins. In addition to limiting habitat accessibility, dams affect habitat quality through changes in river hydrology, altered temperature profile, reduced downstream gravel recruitment, and the reduced recruitment of large woody debris. Such changes can have significant negative impacts on salmonids (e.g., increased water temperatures resulting in decreased disease resistance) (Spence et al. 1996; McCullough 1999). However, over the past several years modifications have occurred to existing barriers, which have reduced the number of basins with limited anadromous access to historical habitat. The completion of the Elwha and Glines Canyon dam removals occurred in 2014. The response of fish populations to this action is still being evaluated. It is clear; however, that Chinook and steelhead are accessing much of this newly available habitat. Hatchery operations in the North Fork Skokomish River are ongoing to supplement the winter steelhead population in the lower North Fork, below the Cushman dams (2). Passage facilities are operational at the dams that would allow access to habitat in the upper North Fork when or if steelhead are passed in the future. A new fish collection facility is operational at the Mud Mountain Dam (White River Basin). Improvements are ongoing to increase the collection efficiency and survival rates, but the facility is expected to improve adult survival and utilization of habitat above the dam. The recent removal of the diversion dam on the Middle Fork Nooksack Dam (16 July 2020) and the Pilchuck River Dam (late 2020) will provide access to important headwater salmonid spawning and rearing habitats. Similarly, the proposed modification of Howard Hanson Dam for upstream fish passage and downstream juvenile collection in the longer term (NMFS 2019f) will allow winter steelhead to return to historical habitat (Ford 2022).

As of 2019 approximately 8,000 culverts that block steelhead habitat have been identified in Puget Sound (NMFS 2019g), with plans to address these blockages being extended over many years. Smaller scale improvements in habitat, restoration of riparian habitat and reconnecting side- or off-channel habitats, will allow better access to habitat types and niche diversification. While there have been some significant improvements in restoring access, it is recognized that land development, loss of riparian and forest habitat, loss of wetlands, demands on water allocation all continue to degrade the quantity and quality of available fish habitat (Ford 2022).

In summary, even with restoration success, like dam removal and blocked culverts being addressed, critical habitat for salmon and steelhead throughout the Puget Sound basin continues to be degraded by numerous management activities, including hydropower development, loss of mature riparian forests, increased sediment inputs, removal of large wood, 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 in areas of critical habitat. As mentioned above, development of shoreline and estuary areas of Puget Sound is expected to continue to adversely impact the quality of marine habitat for PS salmonids. Projected changes in nearshore and estuary development based on documented rates of developed land cover change in Bartz et al. (2015) show that between 2008 and 2060, an additional 14.7 hectares of development of shoreline areas and 204 hectares of estuary development can be expected.[51]

The PS recovery domain CHART for PS Chinook salmon and HCSR chum salmon (NOAA Fisheries 2005) determined that only a few watersheds with PCEs for Chinook salmon 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. Most HUC_5 watersheds are in fair-to-poor or fair-to-good condition. However, most of these watersheds have some or a high potential for improvement (Table 13).

[51] Memorandum from Tim Beechie, Northwest Fisheries Science Center, to Kim Kratz, et al. NMFS, regarding projected developed land cover change in Puget Sound nearshore and estuary zones. (June 23, 2020).

Table 13. Puget Sound Recovery Domain: Current and potential quality of HUC_5 watersheds identified as supporting historically independent populations of ESA-listed Chinook salmon (CK) and chum salmon (CM) (NOAA Fisheries 2005). Watersheds are ranked primarily by "current quality" and secondly by their "potential for restoration."

Current PCE Condition	Potential PCE Condition
3 = good to excellent 2 = fair to good 1 = fair to poor 0 = poor	3 = highly functioning, at historical potential 2 = high potential for improvement 1 = some potential for improvement 0 = little or no potential for improvement

Watershed Name(s) and HUC_5 Code(s)	Listed Species	Current Quality	Restoration Potential
Strait of Georgia and Whidbey Basin #1711000xxx			
Skagit River/Gorge Lake (504), Cascade (506) & Upper Sauk (601) rivers, Tye & Beckler rivers (901)	CK	3	3
Skykomish River Forks (902)	CK	3	1
Skagit River/Diobsud (505), Illabot (507), & Middle Skagit/Finney Creek (701) creeks; & Sultan River (904)	CK	2	3
Skykomish River/Wallace River (903) & Skykomish River/Woods Creek (905)	CK	2	2
Upper (602) & Lower (603) Suiattle rivers, Lower Sauk (604), & South Fork Stillaguamish (802) rivers	CK	2	1
Samish River (202), Upper North (401), Middle (402), South (403), Lower North (404), Nooksack River; Nooksack River (405), Lower Skagit/Nookachamps Creek (702) & North Fork (801) & Lower (803) Stillaguamish River	CK	1	2
Bellingham (201) & Birch (204) bays & Baker River (508)	CK	1	1
Whidbey Basin and Central/South Basin #1711001xxx			
Lower Snoqualmie River (004), Snohomish (102), Upper White (401) & Carbon (403) rivers	CK	2	2
Middle Fork Snoqualmie (003) & Cedar rivers (201), Lake Sammamish (202), Middle Green River (302) & Lowland Nisqually (503)	CK	2	1
Pilchuck (101), Upper Green (301), Lower White (402), & Upper Puyallup River (404) rivers, & Mashel/Ohop(502)	CK	1	2
Lake Washington (203), Sammamish (204) & Lower Green (303) rivers	CK	1	1
Puyallup River (405)	CK	0	2
Hood Canal #1711001xxx			
Dosewallips River (805)	CK/CM	2	1/2
Kitsap – Kennedy/Goldsborough (900)	CK	2	1
Hamma Hamma River (803)	CK/CM	1/2	1/2

Current PCE Condition	Potential PCE Condition
3 = good to excellent 2 = fair to good 1 = fair to poor 0 = poor	3 = highly functioning, at historical potential 2 = high potential for improvement 1 = some potential for improvement 0 = little or no potential for improvement

Watershed Name(s) and HUC_5 Code(s)	Listed Species	Current Quality	Restoration Potential
Lower West Hood Canal Frontal (802)	CK/CM	0/2	0/1
Skokomish River (701)	CK/CM	1/0	2/1
Duckabush River (804)	CK/CM	1	2
Upper West Hood Canal Frontal (807)	CM	1	2
Big Quilcene River (806)	CK/CM	1	1/2
Deschutes Prairie-1 (601) & Prairie-2 (602)	CK	1	1
West Kitsap (808)	CK/CM	1	1
Kitsap – Prairie-3 (902)	CK	1	1
Port Ludlow/Chimacum Creek (908)	CM	1	1
Kitsap – Puget (901)	CK	0	1
Kitsap – Puget Sound/East Passage (904)	CK	0	0
Strait of Juan de Fuca Olympic #1711002xxx			
Dungeness River (003)	CK/CM	2/1	1/2
Discovery Bay (001) & Sequim Bay (002)	CM	1	2
Elwha River (007)	CK	1	2
Port Angeles Harbor (004)	CK	1	1

Puget Sound Rockfish Critical Habitat

NMFS designated critical habitat for PS/GB yelloweye and PS/GB bocaccio rockfish on November 13, 2014 (79 FR 68042). Critical habitat is not designated in areas outside of U.S. jurisdiction; therefore, although waters in Canada are part of the DPSs' ranges for both species, critical habitat was not designated in that area. The U.S. portion of the Puget Sound/Georgia Basin that is occupied by PS/GB yelloweye rockfish and PS/GB bocaccio can be divided into five areas, or Basins, based on the distribution of each species, geographic conditions, and habitat features. These five interconnected Basins are: (1) The San Juan/Strait of Juan de Fuca Basin, (2) Main Basin, (3) Whidbey Basin, (4) South Puget Sound, and (5) Hood Canal.

Based on the natural history of PS/GB bocaccio and their habitat needs, NMFS identified two physical or biological features, essential for their conservation: (1) Deepwater sites (>30 meters) that support growth, survival, reproduction, and feeding opportunities; and (2) Nearshore juvenile rearing sites with sand, rock and/or cobbles to support forage and refuge. Habitat threats include degradation of rocky habitat, loss of eelgrass and kelp, introduction of non-native species that modify habitat, and degradation of water quality.

We have determined that approximately 644.7 square miles (1,669.8 sq km) of nearshore habitat for juvenile PS/GB bocaccio and 438.5 square miles (1,135.7 sq km) of deepwater habitat for PS/GB yelloweye rockfish and PS/GB bocaccio meet the definition of critical habitat. Critical habitat for adult PS/GB bocaccio includes 590.4 square miles of nearshore habitat and 414.1 square miles of deepwater habitat.

Nearshore critical habitat for PS/GB bocaccio at juvenile life stages is defined as areas that are contiguous with the shoreline from the line of extreme high water out to a depth no greater than 98 feet (30 m) relative to mean lower low water. The PBFs 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.

Deep water critical habitat includes marine waters and substrates of the U.S. in Puget Sound east of Green Point in the Strait of Juan de Fuca, and serves both adult PS/GB bocaccio, and both juvenile and adult PS/GB yelloweye rockfish. Deepwater critical habitat is defined as areas at depths greater than 98 feet (30 m) that support feeding opportunities and predator avoidance.

The federal register notice for the designation of rockfish critical habitat in Puget Sound notes that many forms of human activities have the potential to affect the essential features of listed rockfish species, and specifically calls out, among others, (1) Nearshore development and in-water construction (e.g., beach armoring, pier construction, jetty or harbor construction, pile driving construction, residential and commercial construction); (2) dredging and disposal of dredged material; (3) pollution and runoff (79 FR 68041;11/13/14) (Table 14). Water quality throughout Puget Sound is degraded by anthropogenic sources within the Sound (e.g. pollutants from vessels) as well as upstream sources (municipal, industrial, and nonpoint sources). Nearshore habitat degradation exists throughout the Puget Sound from fill and dredge to create both fastland and navigational areas for commerce, from shore hardening to protect both residential and commercial waterfront properties, and from overwater structures that enable commercial and recreational boating.

NMFS's 2016 status update identifies recommended future actions including protection and restoration of nearshore habitat through removal of shoreline armoring, and protecting and increasing kelp coverage.

Table 14. Physical or Biological Features of Rockfish Critical Habitat

DPS Basin	Nearshore sq. mi. (for juvenile bocaccio only)	Deepwater sq. mi. (for adult and juvenile yelloweye rockfish and adult bocaccio)	Physical or Biological Features		Activities
San Juan/ Strait of Juan de Fuca	349.4	203.6	Deepwater sites <30 meters) that support growth, survival, reproduction and feeding opportunities	Nearshore juvenile rearing sites with sand, rock and/or cobbles to support forage and refuge	1, 2, 3, 6, 9, 10, 11
Whidbey Basin	52.2	32.2			1, 2, 3, 4, 6, 9, 10, 11
Main Basin	147.4	129.2			1, 2, 3, 4, 6,7, 9, 10, 11
South Puget Sound	75.3	27.1			1, 2, 3, 4, 6,7, 9, 10, 11
Hood Canal	20.4	46.4			1, 2, 3, 6,7, 9, 10, 11

Management Considerations Codes: (1) Nearshore development and in-water construction (e.g., beach armoring, pier construction, jetty or harbor construction, pile driving construction, residential and commercial construction); (2) dredging and disposal of dredged material; (3) pollution and runoff; (4) underwater construction and operation of alternative energy hydrokinetic projects (tidal or wave energy projects) and cable laying; (5) kelp harvest; (6) fisheries; (7) non-indigenous species introduction and management; (8) artificial habitats; (9) research; (10) aquaculture; and (11) activities that lead to global climate change and ocean acidification. Commercial kelp harvest does not occur presently, but would probably be concentrated in the San Juan/Georgia Basin. Artificial habitats could be proposed to be placed in each of the Basins. Non-indigenous species introduction and management could occur in each Basin.

SRKW Critical Habitat

Critical habitat for the SRKW DPS was designated on November 29, 2006 (71 FR 69054). Critical habitat designated at that time included approximately 2,560 square miles of inland waters of Washington in three specific areas: (1) the Summer Core Area in Haro Strait and waters around the San Juan Islands; (2) Puget Sound; and (3) the Strait of Juan de Fuca. Based on the natural history of SRKWs and their habitat needs, NMFS originally identified the following physical or biological features essential to conservation: (1) Water quality to support growth and development; (2) Prey species of sufficient quantity, quality and availability to support individual growth, reproduction and development, as well as overall population growth; and (3) Passage conditions to allow for migration, resting, and foraging.

In 2006, few data were available on SRKWs distribution and habitat use in coastal waters of the Pacific Ocean. Since the 2006 designation, additional effort has been made to better understand the geographic range and movements of SRKWs. For example, opportunistic visual sightings, satellite tracking, and passive acoustic research conducted since 2006 have provided an updated estimate of the whales' coastal range that extends from the Monterey Bay area in California, north to Chatham Strait in southeast Alaska (NMFS 2019b).

On August 2nd, 2021, NMFS revised the critical habitat designation for the SRKW DPS under the ESA by designating six new areas along the U.S. West Coast (86 FR 41668). Specific new areas proposed along the U.S. West Coast include approximately 15,910 square miles (mi^2) (41,207 square kilometers (km^2)) of marine waters between the 6.1-meter (m) depth contour and the 200-m depth contour from the U.S. international border with Canada south to Point Sur, California). In the final rule (86 FR 41668), NMFS states that the "designated areas are occupied and contain physical or biological features that are essential to the conservation of the species and that may require special management considerations or protection." The three physical or biological features essential to conservation in the 2006 designated critical habitat were also identified for the six new areas along the U.S. West Coast.

<u>Water Quality</u>. Water quality supports SRKW's ability to forage, grow, and reproduce free from disease and impairment. Water quality is essential to the whales' conservation, given the whales' present contamination levels, small population numbers, increased extinction risk caused by any additional mortalities, and geographic range (and range of their primary prey) that includes highly populated and industrialized areas. Water quality is especially important in high-use areas where foraging behaviors occur and contaminants can enter the food chain. The absence of contaminants or other agents of a type and/or amount that would inhibit reproduction, impair immune function, result in mortalities, or otherwise impede the growth and recovery of the SRKW population is a habitat feature essential for the species' recovery. Water quality in Puget Sound, in general, is degraded as described in the Puget Sound Partnership 2018-2022 Action Agenda and Comprehensive (Puget Sound Partnership 2018). For example, toxicants in Puget Sound persist and build up in marine organisms including SRKWs and their prey resources, despite bans in the 1970s of some harmful substances and cleanup efforts. Water quality varies in coastal waters from Washington to California. For example, as described in NMFS (2019b), high levels of DDTs have been found in SRKWs, especially in K and L pods, which spend more time in California in the winter where DDTs still persist in the marine ecosystem (Sericano et al. 2014).

Exposure to oil spills also poses additional direct threats as well as longer term population level impacts; therefore, the absence of these chemicals is of the utmost importance to SRKW conservation and survival. Oil spills can also have long-lasting impacts on other habitat features. Oil spill risk exists throughout the SRKW's coastal and inland range. From 2002-2016, the highest-volume crude oil spill occurred in 2008 off the California coast, releasing 463,848 gallons (Stephens 2017). In 2015 and 2016, crude oil spilled into the marine environment off the California coast totaled 141,680 gallons and 44,755, respectively; no crude oil spills were reported off the coasts of Oregon or Washington in these years (Stephens 2015, Stephens 2017). Non-crude oil spills into the marine environment also occurred off California, Oregon, and Washington in 2015 and 2016 (Stephens 2015, Stephens 2017). The Environmental Protection Agency and U.S. Coast Guard oversee the Oil Pollution Prevention regulations promulgated under the authority of the Federal Water Pollution Control Act. There is a Northwest Area Contingency Plan, developed by the Northwest Area Committee, which serves as the primary guidance document for oil spill response in Washington and Oregon. In 2017, the Washington State Department of Ecology published a new Spill Prevention, Preparedness, and Response Program Annual Report describing the Spills Program as well as the performance measures from 2007–17 (WDOE 2017).

Prey Quantity, Quality, and Availability. SRKW are top predators that show a strong preference for salmonids in inland waters, particularly larger, older age class Chinook (age class of 3 years or older) (Ford and Ellis 2006, Hanson et al. 2010). Samples collected during observed feeding activities, as well as the timing and locations of killer whales' high use areas that coincide with Chinook salmon runs, suggest the whales' preference for Chinook extends to outer coastal habitat use as well (Hanson et al. 2017, Hanson et al. 2021). Quantitative analyses of diet from fecal samples indicate a high proportion of Chinook in the diet of whales feeding in waters off the coast but a greater diversity of species, which included substantial contributions of other salmon and also lingcod, halibut, and steelhead (Hanson et al. 2021). Habitat conditions should support the successful growth, recruitment, and sustainability of abundant prey to support the individual growth, reproduction, and development of Southern Residents.

Most wild salmon stocks throughout the whales' geographic range are at fractions of their historic levels. Beginning in the early 1990s, 28 ESUs and DPSs of salmon and steelhead in Washington, Oregon, Idaho, and California were listed as threatened or endangered under the ESA. Historically, overfishing, habitat losses, and hatchery practices were major causes of decline. Poor ocean conditions over the past two decades have reduced populations already weakened by the degradation and loss of freshwater and estuary habitat, fishing, hydropower system management, and hatchery practices. While wild salmon stocks have declined in many areas, hatchery production has been generally strong.

In addition to sufficient quantity of prey, those fish need to be accessible and available to the whales. Depending on pod migratory behavior, availability of Chinook along the outer coast is likely limited at particular times of year (e.g. winter months) due to run timing of various Chinook stocks. Prey availability may also be low when the distribution of preferred adult Chinook is relatively less dense (spread out) prior to their aggregation when returning to their natal rivers. Prey availability may also be affected by competition from other predators including other resident killer whales, pinnipeds, and fisheries (Chasco et al. 2017).

Contaminants and pollution also affect the quality of SRKW prey in Puget Sound and in coastal waters of Washington, Oregon, and California. Contaminants enter marine waters and sediment from numerous sources, but are typically concentrated near areas of high human population and industrialization. Once in the environment these substances proceed up the food chain, accumulating in long-lived top predators like SRKWs. Chemical contamination of prey is a potential threat to SRKW critical habitat, despite the enactment of modern pollution controls in recent decades, which were successful in reducing, but not eliminating, the presence of many contaminants in the environment. The size of Chinook salmon is also an important aspect of prey quality (i.e., SRKWs primarily consume large Chinook) so changes in Chinook size (for instance as shown by Ohlberger et al. (2018)) may affect the quality of this component critical habitat.

Availability of prey to the whales may also be impacted by anthropogenic sound if it raises average background noise to a level that is expected to chronically or regularly reduce the effective zone of echolocation space for SRKW (Holt 2008, Veirs et al. 2016, Joy et al. 2019), and therefore could limit a whale's ability to find/access the prey critical habitat feature. For example, ship noise was identified as a concern because of its potential to interfere with SRKW communication, foraging, and navigation (Veirs et al. 2016). In-water anthropogenic sound is generated by other sources beside vessels, including construction activities, and military operations, and may affect availability of prey to Southern Residents by interfering with hearing, echolocation, or communication depending on the intensity, persistence, timing, and location of certain sounds in the vicinity of the whales (see review in NMFS 2008a). Therefore, anthropogenic noise may affect the availability of prey to Southern Residents by reducing echolocation space used for foraging and communication between whales (including communication for prey sharing).

SRKW might shift their distribution in response to climate-related changes in their salmon prey, as discussed above in Section "Climate change and other ecosystem effects" and climate change may have impacts on the prey feature of critical habitat.

Passage. Southern Residents are highly mobile and use a variety of areas for foraging and other activities, as well as for traveling between these areas. Human activities can interfere with movements of the whales and impact their passage. Southern Residents require open waterways that are free from obstruction (e.g., physical, acoustic) to move within and migrate between important habitat areas throughout their range, communicate, find prey, and fulfill other life history requirements. In particular, vessels may present obstacles to whale passage, causing the whales to swim further and change direction more often, which can increase energy expenditure for whales and impacts foraging behavior (review in NMFS (2010), Ferrara et al. (2017).

2.3. Action Area

"Action area" means all areas to be affected directly or indirectly by the federal action and not merely the immediate area involved in the action (50 CFR 402.02). The action area consists of all the areas where the environmental effects of actions authorized by the Corps under this program may occur, which extends throughout the Salish Sea area of Western Washington. This includes the Strait of Juan de Fuca, North Puget Sound/San Juan Islands, Hood Canal, Whidbey Basin and the South Central Sound (Figure 16). The action area includes all tidal areas (i.e., marine or estuary), adjacent wetlands which would be directly affected by proposed activities and adjacent non-tidal areas (i.e., upland, riparian) where indirect effects of the action are reasonably certain to occur. The action area extends into estuaries and rivers up to the highest point of saltwater influence. There is overlap between the areas impacted by the proposed action and the range of ESA-listed salmon, steelhead, green sturgeon, eulachon, rockfish, and Southern Resident killer whales, and designated critical habitat.

Figure 16. Marine basins of Puget Sound

As further explained in our analysis below, enduring effects caused by the proposed structures would result in a reduction in nearshore habitat quality. Even though some of the activities covered by SSNP require conservation offsets to compensate for these effects, the effects still occur and are used to define the action area. This reduction in habitat quality would reduce survival of juvenile PS Chinook salmon. This in turn would reduce the abundance of adult PS Chinook salmon, resulting in less forage for SRKWs. SRKWs forage in coastal areas from Southeast Alaska and British Columbia to Central California, as well as within the Salish Sea including the Strait of Georgia, the Strait of Juan de Fuca, and Puget Sound (Hanson et al. 2021, Hanson et al. 2010, Krahn et al. 2004). In the straits of Georgia and Juan de Fuca, SRKWs primarily prey on Chinook salmon from the Fraser River. PS Chinook salmon comprise only a small portion of the Chinook salmon consumed in the straits. (Hanson et al. 2021). In coastal areas, SRKWs prey on Chinook salmon from multiple areas including the Columbia River and the California Central Valley. PS Chinook salmon only represent a small portion of the Chinook salmon consumed by SRKWs in coastal areas (Hanson et al. 2021, Hanson et al. 2010). In contrast, in Puget Sound itself, PS Chinook salmon represent a much larger portion of the Chinook salmon consumed by SRKWs. Hanson et al. 2021, found that 67 percent of Chinook salmon found in SRKW prey remain samples collected in Puget Sound were estimated to have originated from Puget Sound. Any reduction in Chinook salmon forage for SRKWs, caused by the loss of nearshore habitat quality, that would be caused by the proposed action, manifests predominantly within the Salish Sea.

Construction of new overwater structures and the repair or replacement of existing overwater structures is included as part of the proposed action. The purpose of many of these structures, such as residential pier, ramp, and floats, and commercial marinas, wharfs or port facilities, is to provide mooring locations for commercial and recreational vessels. Because the primary purpose of these structures is to provide moorage for vessels, it is reasonably certain that the structures will generate some future vessel operation. Intermittent impacts from these vessels would include noise, propeller wash, shading of nearshore areas when vessels are moored, and the introduction of a small amount of contaminants (i.e., fuel).

Recreational and commercial vessel use associated with overwater structures would be most concentrated around the structures themselves. However, the vessels can travel throughout the Salish Sea. We expect this to be particularly true for vessels using commercial structures and larger recreational vessels moored at marinas and ports. Given the number of vessels mooring at some of the project sites and the variety of reasons for vessel use including commercial shipping, fishing, site seeing, and wildlife watching, emergency use, and recreational use, we expect the vessel use to be well spread out through the Salish Sea.

When all of the areas affected by the proposed action are considered collectively, the following areas become the action area for this programmatic action: the (1) Strait of Juan de Fuca, (2) North Puget Sound/San Juan Islands, (3) Hood Canal, (4) Whidbey Basin and the (5) South Central Sound. In this document, we refer to this area as the Salish Sea

The action area is designated as EFH for Pacific Coast salmon (PFMC 2014), Pacific groundfish, and coastal pelagics or is in an area where environmental effects of the proposed action may adversely affect designated EFH for those species.

2.4. Environmental Baseline

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

2.4.1. Current Status of Salish Sea

Salish Sea can be generally described as nearshore and deepwater areas. NMFS has identified the several nearshore and deepwater physical or biological features essential to conservation for salmon, rockfish and SRKW in Section 2.2.2.

The nearshore is the zone where marine water, fresh water, and terrestrial landscapes interact in a complex mosaic of habitats and processes. The nearshore encompasses the shoreline from the top of the upland bank or bluff on the landward side down to the depth of water that light can penetrate and where plants can photosynthesize, called the photic zone. The upper extent of the nearshore covers the terrestrial upland that contributes sediment, shade, organic material like leaf litter, and even the insects that fish eat. The lower range of the photic zone depends on water clarity; in Puget Sound, underwater vegetation can be found to depths of 30 to 100 feet below Mean Lower Low Water (MLLW) (Williams and Thom 2001). The nearshore includes a variety of environments: marine shallows, eelgrass meadows, kelp forests, mudflats, beaches, salt marshes, rocky shores, river deltas, estuaries, barrier islands, spits, marine riparian zones, and bluffs. This wide range of habitats supports many species. The nearshore forms the basis for the biologic productivity of the Puget Sound basin.

The most notable past and present human activities that cause adverse effects on salmon include the four H's: land use activities that result in **habitat** loss and degradation, **hatchery** practices, **harvest**, and **hydropower** systems.

Habitat Actions

Activities that affect salmon habitat such as agriculture, forestry, marine construction, levy maintenance, shoreline armoring, dredging, hydropower operations and new development continue to limit the ability of the habitat to produce salmon, and thus limit prey available to SRKWs in the action area. Many of these activities have a federal nexus and have undergone section 7 consultation. Those actions have nearly all met the standard of not jeopardizing the continued existence of the listed salmonids or adversely modifying their critical habitat, and when they did not meet that standard, NMFS identified RPAs. Chinook salmon currently available to the SRKW are still below their pre-ESA listing levels, largely due to past activities that pre-date the salmon listings. Since the SRKWs were listed, federal agencies have consulted on impacts to the whales from actions affecting salmon by way of habitat modification.

Landscape Overview

When considered at the landscape scale, the baseline condition of Salish Sea nearshore habitat is degraded overall, with reduced water quality, reduced forage and prey availability, reduced quality of forage and prey communities, reduced amount of estuarine habitat, reduced quality of nearshore and estuarine habitat, and reduced condition of migration habitat due to structure noise and vessel perturbations. Each of these baseline conditions exerts downward pressure on affected cohorts of all populations of listed species considered in the Opinion for the duration of their time in the action area. Loss of production of Chinook salmon from habitat degradation reduces available forage for SRKWs. The baseline currently constrains the carrying capacity of the action area and limits the potential recovery of these species. Overall, the nearshore is degraded from coastal development and pollution. The input of pollutants affects water quality, sediment quality, and food resources in the nearshore and deep-water areas of critical habitat.

Nearshore habitat in Hood Canal has been plagued by an increase in hypoxia, however many inter- and subtidal areas evaluated in a 2002 study were found to be dominated by the dense eelgrass and sand habitat classes, suggesting multiple areas of high habitat quality were present in the Hood Canal nearshore (Garono et al. 2002). Daubenberger et al. (2017) document that Port Gamble Bay, Port Ludlow, and Kilisut Harbor are relatively shallow embayments within the greater Hood Canal system with a highly productive aquatic environment allowing for the presence of eelgrass and attached macroalgae. These three embayments consistently had higher densities of single target detections of juvenile salmonids that may be explained by the presence of abundant zooplankton and larval forage fish. Port Gamble Bay, Port Ludlow, and Kilisut Harbor include productive spawning grounds for Pacific herring, surf smelt, and sand lance, which leads to high densities of larvae that are high energy prey items for juvenile salmonids. Additionally, juvenile chum, pink, and Chinook salmon prey heavily upon crab zoea and megalops, which were found in high densities in these three embayments, likely due to the presence of vegetated habitat (Fernandez et al. 1993).

Overwater Structures and Shoreline Modifications

Although shoreline modifications occur and are typically evaluated on the site scale, the aggregate of these individual impacts diminish and disrupt entire ecosystems at the landscape scale. Shoreline modification can cause fragmentation of the landscape that disrupts connectivity and reduces the productivity and biological diversity of Puget Sound watersheds. These impacts leave ecosystems less resilient.

Throughout the Salish Sea, the nearshore areas have been modified by human activity, disrupting the physical, biological, and chemical interactions that are vital for creating and sustaining the diverse ecosystems of this area. There are approximately 503,106 acres of overwater structure in the nearshore of Puget Sound (Schlenger et al. 2011) and approximately 27 percent of Puget Sound's shoreline has been modified by armoring (Simenstad et al. 2011). The shoreline modifications are usually intended for erosion control, flood protection, sediment management, or for commercial, navigational, and recreational uses. Seventy-four percent of shoreline modification in Puget Sound consists of shoreline armoring (Simenstad et al. 2011), which usually refers to bulkheads, seawalls, or groins made of rock, concrete, or wood. Other modifications include jetties and breakwaters designed to dissipate wave energy, and structures such as tide gates, dikes, and marinas, overwater structures, including bridges for railways, roads, causeways, and artificial fill. Analyses conducted in 2011 through the Puget Sound Nearshore Ecosystem Restoration Project (Fresh et al. 2011; Simenstad et al. 2011), and supported by Beechie et al. (2017), found that since 1850, of the approximately 2,470 miles of Puget Sound shoreline:

- Shoreline armoring has been installed on 27 percent of Puget Sound shores (Table 15).
- One-third of bluff-backed beaches are armored along half their length. Roads and nearshore fill have each affected about 10 percent of the length of bluff-backed beaches.
- Forty percent of Puget Sound shorelines have some type of structure that impacts habitat quality.
- Conversion of natural shorelines to artificial shoreforms occurred in 10 percent of Puget Sound (Table 16).
- There has been a 93 percent loss of freshwater tidal and brackish marshes. The Duwamish and Puyallup rivers have lost nearly all of this type of habitat.
- A net decline in shoreline length of 15 percent as the naturally convoluted and complex shorelines were straightened and simplified. This represents a loss of 1,062 km or 660 miles of overall shoreline length.
- Elimination or isolation of small coastal embayments has led to a decline of 46 percent in shoreline length in these areas.
- A 27 percent decline in shoreline length in the deltas of the 16 largest rivers and a 56 percent loss of tidal wetlands in the deltas of these rivers.

Table 15. Total area of over water structures by sub-basin observed in aerial photo review between 2013 and 2016 (Beechie et al. 2017).

Marine Basin	Acres
Hood Canal	233
North Puget Sound	281
South Central Puget Sound	817
Strait of Juan de Fuca	65
Whidbey Basin	186
Total	1581

The distribution and sizes of overwater structures in the nearshore[52] are detailed further in Schlenger et al. (2011) and (Simenstad et al. 2011).

[52] The nearshore area includes the area from the deepest part of the photic zone landward to the top of shoreline bluffs, or in estuaries upstream to the head of tidal influence (Clancy et al. 2009).

Table 16. Length of shoreline armored as a percent of total shoreline length (Simenstad et al. 2011) by Marine Basin (Beechie et al. 2017).

Marine Basin	Armoring (miles)	Shoreline Length (miles)	Percent Armored
Hood Canal	63.9	359.7	17.7%
North Puget Sound	103.3	720.4	14.3%
South Central Puget Sound	397.0	832.6	47.7%
Strait of Juan de Fuca	33.0	210.3	15.7%
Whidbey Basin	68.3	343.4	19.9%
Grand Total	**665.3**	**2466.3**	**27.0%**

Puget Sound nearshore and deep marine waters are fundamental to many life histories of salmon and steelhead and particularly crucial for PS Chinook salmon juvenile (parr, fry, sub-yearling), and sub adult life stages. Juvenile salmon use nearshore habitat extensively during the early marine period (Duffy et al. 2005), a critical time for salmon growth, as larger, faster-growing fish have increased probabilities of surviving to adulthood (Beamish et al. 2004; Duffy and Beauchamp 2011). As mentioned in section 2.2.1 above, the loss of nearshore habitat is considered a factor in the loss of PS salmon abundance and productivity. Reduction in nearshore habitat quality has reduced survival at multiple life stages. Marine survival rates of PS Chinook salmon in Puget Sound have declined drastically since 1980 (Ruggerone and Goetz 2004, Sharma et al. 2012, Ruff et al. 2017). Smolt-to-adult survival rates for hatchery-reared sub-yearling Chinook salmon within Puget Sound have averaged less than one percent over the past three decades (Kilduff et al. 2014).

There is also evidence that loss of nearshore habitat quality may be eliminating PS Chinook salmon life history strategies that make use of nearshore areas during the early life stages. Campbell et al. (2017) found less than three percent of adults returning to the Green and Puyallup Rivers to exhibit the fry migrant life history while approximately 95 percent of their estuary habitat has been eliminated. The converse was true from the Skagit and Nooksack estuaries where approximately 50 percent of the estuary remained in a natural state (Beechie et al. 2017) and 36 and 24 percent of the adult population we examined returned from small fry sized fish, respectively.

From 2005 to 2011, in Puget Sound an average of 1.1 miles per year of new shoreline armoring was permitted in and 2.3 miles per year of replacement armoring was permitted (Johannessen et al 2014). These figures do not include unpermitted structures, which can exceed those constructed with permits. For example, in the Green/Duwamish River Watershed (Water Resources Inventory Area 9), permitted structures comprised only 38 percent of all the armoring physically surveyed in 2012 and 2013 (King County 2014).

Residential parcels make up 57 percent of Puget Sound shorelines and 48 percent of these are armored. In some areas, armoring is even more prevalent: more than 50 percent of the residential parcels are armored in King, Kitsap, Pierce, Snohomish, Mason, and Thurston counties. Overall, 26 percent of residential parcels are in forage fish spawning grounds and 58 percent of those are armored (PSMNGP 2014). In a survey of HPAs issued by WDFW in Puget Sound between January 2005 and December 2010 the data recorded the installation of 6.5 miles of new armor and 14.45 miles of replacement armor. This starkly contrasts with data from that same time period that shows only 0.61 miles of armor were removed (Carman et al. 2011). More recent studies have suggested a less dramatic rate of new armoring, but those studies were limited in their geographic scope and types of shoreline modification.[53] The studies have, however, corroborated that the bulk of permitted shoreline armoring activities continue to be repair and replacement. This demonstrates that the lifecycle of structures that includes the repair or replacement of aging armoring and other in- or over-water structures in Puget Sound extends the duration of degraded baseline conditions and retains limits on habitat features and corresponding carrying capacity.

The duration of impairment of habitat condition and function that derive from decades of persistent anthropogenic changes in the amount of and character of estuarine habitat, is made more detrimental due to the compounding nature of these effects, occurring because: (1) regulatory and permitting measures often have not avoided all impacts to ESA listed species and habitat and have not typically included methods to rectify all unavoidable impacts; (2) development pressure continues to impact habitat in the marine and freshwater portion of the range; (3) improvements in human use patterns to minimize resource impacts are slow at best; and (4) few of the 2020 improvement targets identified by the Puget Sound Partnership (PSP)[54] have been reached (Puget Sound Partnership 2021, https://vitalsigns.pugetsoundinfo.wa.gov/VitalSignIndicator/Detail/42). In more detail, this most recent report points out the following issues:

- PS Chinook salmon, steelhead and SRKW: ongoing decline.
- Herring stocks: declining
- Loss of non-federal forested land cover to developed land cover: continuing. Loss of 1,196 acres of non-federal forested land per year between 2006 and 2011.
- Shoreline armoring: Stable between 2011 and 2014. No recent net increase, restoration actions balance out increase from private shoreline armoring. However, this could be related to poor economic conditions.
- Accelerated conversion/loss of vegetation cover on ecologically important lands: 1.116 percent loss for 2006-2011. This is even more loss than the cautious 2020 Target: Basin-wide loss of vegetation cover on ecologically important lands under high pressure from development does not exceed 0.15 percent of the total 2011 baseline land area over a 5-year period.
- Marine water quality: Overall, trends have been getting worse with closures of beaches and shellfish harvest in some bays. While there has been some increase between 2011 and 2014 in the amount of shellfish beds open to harvest, about 19 percent are still closed. PCB levels in fish[7] are still high.

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[53] Shoreline Permitting through TACT (Spring 2015) (TACT is an acronym for: Trouble-Shooting, Action Planning, Course Correction, and Tracking and Monitoring).
[54] The PSP Action Agenda is an EPA-approved recovery plan under the National Estuary Program.

- Native Eelgrass (*Z. marina*) abundance seems stable comparing 2011 to 2013 data to baseline from 2000 to 2008. This does not account for losses that occurred prior to 2000.
- Human Sound Behavior Index: No change in average behavior. Thus, an increase in human population is likely to continue to degrade habitat quality. (The Sound Behavior Index tracks 28 human use practices[55] that likely affect habitat and water quality and quantity).
- Over Water Structure (OWS): not assessed by PSP. Current percent of nearshore coverage is 0.63 percent for all of Puget Sound, as detailed below.

The PSP concludes the overall decline in habitat conditions and native species abundance in the Puget Sound has been caused by development and climate change pressures. Over the last 150+ years, 4.5 million people have settled in the Puget Sound region. With the level of infrastructure development associated with this population growth, the Puget Sound nearshore has been altered significantly. Major physical changes documented include the simplification of river deltas, the elimination of small coastal bays, the reduction in sediment supplies to the foreshore due to beach armoring, and the loss of tidally influenced wetlands and salt marsh (Fresh et al. 2011).

In addition to beach armoring, other shoreline changes including OWS, marinas, roads, and railroads reduce habitat quality. The amount of these changes varies, and their source varies by region, generally correlating with development, but overall is staggering (Simenstad et al. 2011). The simplification of the largest river deltas has caused a 27 percent decline in shoreline length compared to historical conditions. Of 884 historic small embayments, 308 have been eliminated. About 27 percent of PS's shorelines are armored and only 112 of 828 shoreline segments remain in properly functioning condition. The loss of tidal wetlands in the largest deltas averages 26 percent (Fresh et al. 2011). Each of these habitat changes is related to development and overall reduces the quality and quantity of PS Chinook and HC summer-run chum salmon, in the Puget Sound nearshore.

Existing shoreline armoring on nearshore and intertidal habitat function has diminished sediment supply, diminished organic material (e.g. woody debris and beach wrack) deposition, diminished overwater (riparian) and nearshore in-water vegetation (SAV), diminished prey availability, diminished aquatic habitat availability, diminished invertebrate colonization, and diminished forage fish populations (see Toft et al. 2007; Shipman et al. 2010; Sobocinski et al. 2010; Morley et al. 2012; Toft et al. 2013; Munsch et al. 2014; Dethier et al. 2016). In some locations shoreline armoring has caused increased beach erosion waterward of the armoring, which, in turn, has created beach lowering, coarsening of substrates, increases in sediment temperature, and reductions in invertebrate density (Fresh et al. 2011; Morley et al. 2012; Dethier et al. 2016).

Shoreline armoring has reduced suitable habitat for forage species (Pacific sand lance and surf smelt) spawning and likely has reduced their abundance and productivity. Bulkheads alter habitat conditions for the duration that they are present and simultaneously diminish or eliminate intertidal habitat for forage species including sand lance, an obligate upper intertidal spawner

[55] Human use practices include among others: (a) Number of residents with native vegetation on banks of waterways; (b) number of residents using pump stations for boat wastewater; (c) residents using herbicides and pesticides; and (d) pasture practices for residents with livestock.

(Whitman et al. 2014). As stated in Fresh et al. (2011) "we can only surmise how much forage fish spawning habitat we have lost because we lack comprehensive historical data on spawning areas." Considering that these forage fish are an essential food source for salmon, beach armoring has multiple negative effects on salmon including reductions in prey and reductions in access to shallow water rearing habitat and refuge (Davis et al. 2020).

Activities that NMFS has consulted on that affect salmon habitat and therefore also likely limit prey available to SRKWs include hydropower projects (Mud Mountain Dam (NMFS 2014d); Howard Hanson Dam, Operation, and Maintenance (NMFS 2019d)), the National Flood Insurance program (NMFS 2008g), and 39 habitat modifying projects in the nearshore marine areas of Puget Sound (NMFS 2020g). When actions did not meet the standard of not jeopardizing the continued existence of the listed salmonids or SRKWs or not adversely modifying their critical habitat, NMFS identified RPAs.

On November 9, 2020, NMFS issued a biological opinion for 39 projects proposing in water, overwater and near-water structures in the nearshore marine habitats of Puget Sound (WCRO-2020-01361), a second biological opinion on 11 projects on September 30, 2021 (WCRO-2021-01620), and a third biological opinion on 15 projects on May 11, 2022 (WCRO-2021-03047). In those Opinions, we determined the Corps' proposed action, to permit the projects, was likely to jeopardize the continued existence of listed PS Chinook salmon and SRKW and was likely to adversely modify those species' designated critical habitats. We also determined that the proposed action was not likely to jeopardize listed PS steelhead, PS/GB bocaccio rockfish, PS/GB yelloweye rockfish, or Hood Canal Summer-run chum salmon or adversely modify designated critical habitat for those four species. Our conclusions were based on:

- PS Chinook salmon populations are far from meeting recovery goals and trends in abundance and productivity are mostly negative.
- Nearshore habitat quality is insufficient to support conservation of this ESU. SRKW prey is at a fraction of historical levels. Under the current environmental baseline, nearshore habitat in Puget Sound cannot support the biological requirements of PS Chinook salmon.
- Fewer populations of PS Chinook salmon contributing to SRKW's prey base will reduce the representation of diversity of life histories, resiliency in withstanding stochastic events, and redundancy to ensure there is a margin of safety for the salmon and SRKWs to withstand catastrophic events.
- The condition of the environmental baseline is such that additional impacts on the quality of nearshore habitat is likely to impair the ability of that habitat to support conservation of these species.
- The proposed action would further reduce the quality and quantity of nearshore habitat in Puget Sound.
- The proposed action would also exacerbate habitat limiting factors identified by the PS Chinook salmon and SRKW recovery plans and are inconsistent with recovery action listed in these plans. Due to demand for future human development cumulative effects on nearshore habitat quality are expected to be mostly negative.

The 2020, 2021, and 2022 jeopardy opinions included an RPA with five elements, including on site habitat improvements; off-site habitat improvements; funding from a habitat restoration sponsor; purchase of credits from a conservation bank in-lieu fee program, or crediting provider; and, project modifications. The RPA utilized a Habitat Equivalency Analysis methodology and the Nearshore Habitat Values Model to establish a credit/debit target of no-net-loss of nearshore habitat quality. The RPA was designed to achieve a reduction of project debits to zero, which the Opinions concluded was required to avoid jeopardizing the continued existence of, and adversely modifying critical habitat for, PS Chinook salmon and SRKWs.

The funding initiative for U.S. domestic actions associated with the new Pacific Salmon Treaty (PST) Agreement (NMFS 2019e), in addition to increased hatchery production, includes funding for habitat restoration projects to improve habitat conditions for specified populations of Puget Sound Chinook salmon. By improving conditions for these populations, we anticipate Puget Sound Chinook salmon abundance would increase and thereby benefit SRKWs.

Dredging

The 1988 Environmental Impact Statement (EIS) for the Puget Sound Dredge Disposal Analysis (PSDDA) documented 34 port districts within the Puget Sound region (https://www.nws.usace.army.mil/Missions/Civil-Works/Dredging/Reports/ (this is the most recent information that could be located). This EIS identifies 50 miles of navigation channels, about 50 miles of port terminal ship berths, and more than 200 small boat harbors that must be periodically dredged to maintain the commercial and recreational services provided by these facilities.

Between 1996 and 2014, maintenance dredging resulted in at least 25 million cubic yards of sediment being removed from nearshore environments and disposed of in multi-user disposal sites by Puget Sound harbors and waterways by various dredgers (Table 17). These included private developers and public entities (e.g., federal and state agencies, ports, and local governments) responsible for funding and undertaking dredging projects.

These dredging activities are generally limited to nearshore environments. Regular dredging maintenance, including that described above, results in periodic short-term water quality degradation suspending sediments above background levels and re-suspendeing contaminants. This also results in periodic removal of sediments that support invertebrate prey and forage species for salmon and rockfish (Jones and Stokes 1998, McCabe et al. 1998). According to various studies (Boese et al 2009, Dethier and Schoch 2005, McCabe et al. 1998), a dredged area typically recolonizes in approximately 2 years. Maintenance dredging increases depth and maintains increased depth. This results in a reduction of critical shallow habitat and causes a disruption of the migratory corridor for rearing and migrating juvenile salmonids.

On December 17, 2015, NMFS issued a biological opinion on the continued use of multi-user dredged material disposal sites in Puget Sound and Grays Harbor (WCR-2015-2975). In this biological opinion, we determined the proposed action was likely to adversely affect bocaccio and yelloweye rockfish but not likely to jeopardize the continued existence of these species nor adversely modify their critical habitat. We also concluded the proposed action may affect but was not likely to adversely affect PS Chinook salmon, HCSR chum salmon, PS steelhead, southern DPS of eulachon, southern DPS of green sturgeon, SRKW, and humpback whale.

Disposal of dredge material consistent with this 2015 biological opinion is part of the environmental baseline for this consultation. We expect disposal of some material from dredging projects authorized under SSNP will occur consistent with our 2015 biological opinion. Since the disposal of dredged material at the sites addressed by our 2015 biological opinion is already part of the environmental baseline, we will add the effects of the SSNP proposed dredging to the effects of the disposal in our analysis.

Table 17. Multi-user Disposal Site Volumes by Year (in cubic yards). from: USACE Biological Evaluation for the Continued Use of Multiuser Dredge Material Disposal Sites in Puget Sound and Grays Harbor. Available at: https://usace.contentdm.oclc.org/utils/getfile/collection/p266001coll1/id/9083, last visited December 2, 2021.

Dredging Year[1]	Bellingham Bay	Port Gardner	Elliott Bay	Commencement Bay	Anderson Ketron	Rosario Strait	Port Townsend	Port Angeles	Point Chehalis	South Jetty	Annual Total
1989	---[2]	0	4,097	6,648	---[2]	---[2]	---[2]	---[2]	These years preceded implementation of the DMMP disposal site management plan for Grays Harbor		10,745
1990	0	992,074	129,542	0	0	0	0	0			1,121,616
1991	0	17,261	12,000	10,900	0	566,694	0	0			606,855
1992	0	0	230,241	0	0	43,850	0	0			274,091
1993	32,883	109,500	17,282	0	10,197	176,486	22,642	0			368,990
1994	0	236,749	132,770	0	0	57,010	0	0			426,529
1995	0	143,510	93,412	290,857	8,677	25,250	0	0			561,706
1996	44,800	121,246	95,302	460,684	0	205,500	0	22,344	370,203	1,674,267	2,994,346
1997	0	102,531	18,982	0	0	0	0	0	665,388	959,249	1,746,150
1998	1,200	0	110,465	693,540	0	53,000	4,000	0	357,388	780,181	1,999,774
1999	0	0	414,794	140,319	0	140,761	1,986	0	1,460,361	1,153,621	3,311,842
2000	0	0	360,577	893,776	0	0	0	0	941,782	1,282,663	3,478,798
2001	0	248,965	557,340	265,867	0	10,419	0	0	555,247	358,873	1,996,711
2002	0	45,919	133,270	0	0	0	0	0	88,812	475,199	743,200
2003	0	0		710,675	0	38,223	0	0	85,960	824,694	1,659,552
2004	0	0	15,602	1,205,993	5,772	230,747	0	0	1,022,330	1,166,089	3,646,533
2005	0	0	77,838	949,399	8,180	23,847	0	0	671,819	740,910	2,471,993
2006	0	722,185	3,801	811,000	0	150,921	0	0	1,306,337	196,893	3,191,137
2007	0	4,400	24,250	1,324,254	10,407	20,970	10,996	0	632,366	389,127	2,416,770
2008	0	17,393	172,999	214,858	97,310	0	0	0	927,396	0	1,429,956
2009	0	10,450	20,133	18,803	0	188,580	6,856	0	931,784	21,088	1,197,694
2010	0	371,500	96,046	14,812	0	0	9,048	0	1,054,847	0	1,546,253
2011	0	44,196	11,486	179,160	0	45,865	0	0	802,046	1,012,127	2,094,880
2012	0	34,143	165,700	3,489	10,579	180	0	0	1,606,641	320,985	2,141,717
2013	0	104,199	15,266	1,673	0	144,206	0	0	1,190,142	0	1,455,486
2014	0	0	117,593	0	6,093	0	0	0	1,109,516	0	1,233,202
Site Total:	78,883	3,326,221	3,030,788	8,196,707	157,215	2,122,509	55,528	22,344	15,780,365	11,355,966	44,126,526
CY/year:	3,155	127,932	116,569	315,258	6,289	84,900	2,221	894	830,546	597,682	

Stormwater

Mackenzie et al. 2018 found that stormwater is the primary pathway to Puget Sound for most toxic contaminants, transporting more than half of the Sound's total known toxic load (Ecology and King County 2011). During an extensive Puget Sound monitoring study, toxic chemicals were detected more frequently and at higher concentrations during storm events compared with base flows, demonstrating the impact of untreated stormwater pollution (Ecology 2011). The Puget Sound basin has over 4,500 surface water and stormwater outfalls, with 2,121 discharging treated and untreated stormwater directly into the Puget Sound (WDNR 2015).

Pollutants in stormwater discharge are diverse. As the runoff travels along its path, it picks up and carries away natural and anthropogenic pollutants (U.S. EPA 2016b). Pollutants in stormwater discharge typically include:

- Excess fertilizers, herbicides, insecticides and sediment from landscaping areas.
- Chemicals and salts from de-icing agents applied on sidewalks, driveways, and parking areas.
- Oil, grease, PAHs, 6PPD-quinone and other toxic chemicals from roads and parking areas used by motor vehicles.
- Bacteria and nutrients from animal wastes and faulty septic systems.
- Metals (arsenic, copper, chromium, lead, mercury, and nickel) and other pollutants from the pesticide use in landscaping, roof runoff (WDOE 2014), decay of building and other infrastructure, and as airborne particles from street and tire wear.
- Atmospheric deposition from surrounding land uses.
- Metals, PAHs, PBDEs, and phthalates from roof runoff.
- Erosion of sediment and attached pollutants due to hydromodification.

(Buckler and Granato 1999; Colman et al. 2001; Driscoll et al. 1990; Kayhanian et al. 2003; Van Metre et al. 2005).

Degradation of the nearshore 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 nearshore environment (HCCC 2005; SSPS 2007).

Marine Vessels

Commercial, recreational, military, and public ferry vessel traffic occurs throughout the Salish Sea. Vessels range in size from massive commercial shipping container ships to kayaks. Vessels can access Puget Sound through the Strait of San Juan de Fuca, the Strait of Georgia, ports, public and private marinas, naval bases, single-family piers, public boat ramps, and freshwater piers and marinas. Several studies have shown fish to respond physiologically and biologically to increased noise (Mueller 1980; Scholik and Yan 2002; Picciulin et al. 2010). Xie et al. (2008) report that adult migrating salmon avoid vessels by swimming away. Graham and Cooke (2008) studied the effects of three boat noise disturbances (canoe paddling, trolling motor, and combustion engine (9.9 horsepower) on the cardiac physiology of largemouth bass (*Micropterus salmoides*). Exposure to each of the treatments resulted in an increase in cardiac output in all fish, associated with a dramatic increase in heart rate and a slight decrease in stroke volume, with the most extreme response being to that of the combustion engine treatment (Graham and Cooke 2008). Recovery times were the least with canoe paddling (15 minutes) and the longest with the power engine (40 minutes). They postulate that this demonstrates that fish experienced sublethal physiological disturbances in response to the noise propagated from recreational boating activities. The existing levels of vessel traffic likely cause sublethal physiological stress to listed fish species.

Recent evidence indicates there is a higher energetic cost of surface-active behaviors and vocal effort resulting from vessel disturbance in the Salish Sea (Williams et al. 2006; Noren et al. 2012; Noren et al. 2013; Holt et al. 2015). For example, Williams et al. (2006) estimated that changes in activity budgets in NRKW s in British Columbia's inland waters in the presence of vessels result in an approximate 3 percent increase in energy expenditure compared to when vessels are not present. Other studies measuring metabolic rates in captive dolphins have shown these rates can increase during the more energetically costly surface behaviors (Noren et al. 2012) that are observed in killer whales in the wild, as well as during vocalizations and the increased vocal effort associated with vessels and noise (Noren et al. 2013; Holt et al. 2015). These studies that show an increase in energy expenditure during surface active behaviors and changes in vocal effort may negatively impact the energy budget of an individual, particularly when cumulative impacts of exposure to multiple vessels throughout the day are considered.

However, this increased energy expenditure may be less important than the reduced time spent feeding and the resulting potential reduction in prey consumption (Ferrara et al. 2017). SRKW spent 17 to 21 percent less time foraging in inland waters in the presence of vessels for 12 hours, depending on vessel distance (see Ferrara et al. 2017). Although the impacts of short-term behavioral changes on population dynamics is unknown, it is likely that because SRKWs are exposed to vessels the majority of daylight hours they are in inland waters, there may be biologically relevant effects at the population level (Ferrara et al. 2017).

Additionally, there is growing concern about the effect of increasing ocean noise levels due to anthropogenic sources on marine organisms, particularly marine mammals. Effects of noise exposure on marine organisms can be characterized by the following range of physical and behavioral responses (Richardson et al. 1995):

1. Behavioral reactions—Range from brief startle responses, to changes or interruptions in feeding, diving, or respiratory patterns, to cessation of vocalizations, to temporary or permanent displacement from habitat.
2. Masking—Reduction in ability to detect communication or other relevant sound signals due to elevated levels of background noise.

3. Temporary threshold shift—Temporary, fully recoverable reduction in hearing sensitivity caused by exposure to sound.
4. Permanent threshold shift—Permanent, irreversible reduction in hearing sensitivity due to damage or injury to ear structures caused by prolonged exposure to sound or temporary exposure to very intense sound.
5. Non-auditory physiological effects—Effects of sound exposure on tissues in non-auditory systems either through direct exposure or as a consequence of changes in behavior, (*e.g.*, resonance of respiratory cavities or growth of gas bubbles in body fluids).

Researchers measured underwater sound pressure levels for 1,582 unique ships that transited the core critical habitat of the SRKWs within the action area during 28 months between March 2011 and October 2013. Median received spectrum levels of noise from 2,809 isolated transits were found to be elevated relative to median background levels not only at low frequencies (20–30 dB re 1 $\mu Pa^2/Hz$ from 100 to 1,000 Hz), but also at high frequencies (5–13 dB from 10,000 to 96,000 Hz). Thus, noise received from ships at ranges less than 3 km extended to frequencies used by odontocetes (toothed whales, including SRKW). The researchers found that most ship classes show a linear relationship between source level and vessel speed with a slope near +2 dB per m/s (+1 dB/knot). Mean ship speeds during measurements were 7.3 ± 2.0 m/s (14.1 ± 3.9 knots).

Veirs et al. (2016), found that noise from large ships extends into frequencies used by SRKWs for echolocation. The current estimated good hearing range for killer whales is between 5 and 81 kHz with low and high-frequency cutoffs of 600 Hz and 114 kHz, respectively (Branstetter et al. 2017). Veirs et al. (2016) measured underwater sound pressure levels for 1,582 unique ships that transited the core critical habitat of the SRKWs in Haro Strait during 28 months between March 2011, and October 2013. Median received spectrum levels of noise from 2,809 isolated transits were found to be elevated relative to median background levels not only at low frequencies (20–30 dB re 1 µPa2/Hz from 100 to 1,000 Hz), but also at high frequencies (5–13 dB from 10 to 96 kHz). Thus, noise received from ships at ranges less than 3 km extended to high frequencies used by SRKW. The researchers found that most ship classes show a linear relationship between source level and vessel speed with a slope near +2 dB per m/s (+1 dB/knot). Mean ship speeds during measurements were 7.3 ± 2.0 m/s (14.1 ± 3.9 knots). Some of the noise produced by ships extends to these higher frequencies, which may result in masking or partially or completely preventing the perception of SRKW clicks, calls, and whistles (Viers et al. 2016). Masking of echolocation reduces foraging efficiency (Holt 2008).

Another concern for vessel noise is the potential to cause acoustically induced stress (Miksis et al. 2001) which can cause changes in heart rate, blood pressure, and gastrointestinal activity. Stress can also involve activation of the pituitary-adrenal axis, which stimulates the release of more adrenal corticoid hormones. Stress-induced changes in the secretion of pituitary hormones have been implicated in failed reproduction (Moberg 1987, Rivest and Rivier 1995) and altered metabolism (Elasser et al. 2000), immune competence (Blecha 2000) and behavior.

Larger vessel traffic in Puget Sound generally stay in shipping lanes within the inland waters, they are not targeting or following whales and as the ships are moving while making noise means that the noise is also transitory. As such co-occurrence with large vessel traffic is expected to be short-term and transitory when whale presence overlaps with ship presence. This means vessels not targeting the whales can still cause disturbance and impair the whales' ability to find food and interact with each other. Given this information, large vessels can cause disturbance of SRKW periodically in the action area.

Recent evidence indicates there is a higher energetic cost of surface-active behaviors and vocal effort resulting from vessel disturbance in the Salish Sea (Williams et al. 2006; Noren et al. 2012; Noren et al. 2013; Holt et al. 2015). For example, Williams et al. (2006) estimated that changes in activity budgets in Northern Resident killer whales in inland waters in the presence of vessels result in an approximate 3% increase in energy expenditure compared to when vessels are not present. However, this increased energy expenditure may be less important than the reduced time spent feeding and the resulting potential reduction in prey consumption (Ferrara et al. 2017). Southern Resident killer whales spent 17 to 21% less time foraging in inland waters in the presence of vessels for 12 hours, depending on vessel distance (see Ferrara et al. 2017). In Haro Strait, Holt et al. (2021) found that SRKW descended more quickly when noise levels were higher from vessels and when vessel approaches were closer. They also found that when vessel navigational sonar was used SRKWs made longer dives to capture prey and descended more slowly when they initiated these dives. Thus, vessel-related noise has the potential to result in behavioral disturbance or harassment, including displacement, site abandonment (Gard 1974, Reeves 1977, Bryant et al.1984), masking (Richardson et al. 1995), alteration of diving or breathing patterns, and less responsiveness when feeding. Because SRKWs are exposed to vessels the majority of daylight hours they are in inland waters, there may be biologically relevant effects at the population level (Ferrara et al. 2017).

Fishing vessels are also found in close proximity to the whales and vessels that were actively fishing were responsible for 7 percent of the incidents inconsistent with the Be Whale Wise Guidelines and federal regulations in 2020 (Frayne 2021). In 2020, 92 percent of all incidents (inconsistent with Be Whale Wise guidelines and non-compliant with federal regulations, see (Frayne 2021)) of vessel activities were committed by private/recreational motor vessels, 4 percent private sailing vessels, 3 percent U.S. commercial vessels, less than one percent commercial kayaks, less than one percent Canadian commercial vessels (possibly related to closures due to COVID-19 orders) and less than one percent by commercial fishing vessels (Frayne 2021). In 2021, 73 percent of all incidents (inconsistent with Be Whale Wise guidelines and non-compliant with federal regulations, see (Frayne 2022)) of vessel activities were committed by private recreational vessels, 8 percent U.S. commercial vessels, 6 percent Canadian commercial vessels, 4 percent commercial aircraft, 4 percent commercial fishing vessels, 2 percent maritime cargo/ferries, 2 percent enforcement, <1 percent private aircraft, and <1 percent by research vessels (Frayne 2022). Most incidents in violation of guidelines were violating the 7kt speed limit within ½ mile of whales followed by under power within 200 yards of the whales in 2021. These activities included entering a voluntary no-go zone and fishing within 200 yards of the whales. A number of recommendations to improve compliance with guidelines and regulations are being implemented in inland waters by a variety of partners to further reduce vessel disturbance (Ferrara et al. 2017).

From a study of the Haro Strait Region of Washington and British Columbia (the boundary waters of the Canadian Gulf and San Juan Islands), the majority of vessels in close proximity to

SRKW in inland waters are commercial whale watching vessels and recreational whale watching vessels (Frayne 2021, Seely 2017).and the average number of boats accompanying whales can be high during the summer months (i.e., from 2013 to 2017 an average of 12 to 17 boats (See Seely 2016). In 2020, 92 percent of all incidents (inconsistent with Be Whale Wise guidelines and non-compliant with federal regulations, see (Frayne 2021) of vessel activities were committed by private/recreational motor vessels, 4 percent private sailing vessels, 3 percent U.S. commercial vessels, less than one percent commercial kayaks, less than one percent Canadian commercial vessels (possibly related to closures due to COVID-19 orders) and less than one percent by commercial fishing vessels (Frayne 2021).

Vessels are subject to existing federal regulations prohibiting approach closer than 200 yards or positioning in the path of the whales within 400 yards (with exemptions for vessels lawfully engaged in commercial or treaty Indian fishing that are actively setting, retrieving, or closely tending fishing gear). State regulations also mandate protections for SRKWs (see RCW 77.15.740, mandating 300- to 400-yard approach limits, 7 knots or less speed within ½ nautical mile of the whales). NMFS and other partners have outreach programs in place to educate vessel operators on how to avoid impacts to whales. The average number of vessels with the whales decreased in 2018, 2019 and 2020 likely due to decreased viewing effort on SRKWs by commercial whale watching vessels, with an average of 10, 9, and 10.5 vessels with the whales at any given time, respectively (Frayne 2021). NMFS initiated scoping in 2019 to evaluate the need to revise existing federal regulations.

Hatcheries

The central challenge of operating and managing hatchery programs is finding a balance between the risks and benefits of hatchery production for harvest or conservation. Hatchery production of Chinook salmon and steelhead can be an effective tool to increase fish abundance for conservation and harvest. However, hatcheries can also pose demographic, genetic, and ecological risks to these species. Risks and benefits of hatchery production are best evaluated in the context of the purpose of the hatchery program. Conservation of native populations is one purpose. The primary goal of Chinook salmon and steelhead conservation in Puget Sound is sustainable natural production of locally adapted fish throughout the accessible watersheds (Hard et al. 2015). Thus, to effectively achieve its goals, a conservation hatchery program must increase the abundance, productivity, spatial structure, and/or diversity of a natural-origin steelhead population. In contrast, some hatchery programs have a different goal: to provide harvest opportunities. These hatchery programs may be either integrated or segregated.

Interactions of hatchery- and natural-origin Chinook salmon and steelhead pose different risks to abundance, productivity, genetic diversity, and fitness of fish spawning in the natural environment depending on how hatcheries are operated. A growing body of scientific literature, stemming from improved tools to assess parentage and other close genetic relationships on relative reproductive success of hatchery and natural-origin salmonids, suggests that strong and rapid declines in fitness of natural-produced fish due to interactions with hatchery-produced fish are possible (Araki et al. 2008; Christie et al. 2014). These studies have focused primarily on steelhead, Chinook salmon, coho salmon, and Atlantic salmon. Limited but growing evidence suggests that steelhead may be more susceptible to genetic risk (i.e., domestication) posed by hatchery propagation than other species (Ford et al. 2016). Further, because selective regimes and mortality differ dramatically between natural and cultured populations, some genetic change cannot be avoided (Waples 1999). These changes are difficult to predict quantitatively because there may be considerable variation in relative reproductive success among species, populations, and habitats, as well as temporal variability owing to environmental change.

Beginning in the 1990s, state and tribal co-managers took steps to reduce risks identified for Puget Sound hatchery programs as better information about their effects became available (PSIT and WDFW 2004), in response to reviews of hatchery programs (e.g., Busack and Currens 1995, HSRG 2000, Hatchery Scientific Review Group 2002), and as part of the region-wide Puget Sound salmon recovery planning effort (SSPS 2005). The intent of hatchery reform is to reduce negative effects of artificial propagation on natural populations while retaining proven production and potential conservation benefits. The goals of conservation programs are to restore and maintain natural populations. Hatchery programs in the Pacific Northwest are phasing out use of broodstocks that differ substantially from natural populations, such as out-of-basin or out-of-ESU stocks, and replacing them with fish derived from, or more compatible with, locally adapted populations. The proposed reforms are to ensure that existing natural salmonid populations are preserved, and that hatchery-induced genetic and ecological effects on natural populations are minimized.

Nearly half of the hatchery programs in Puget Sound incorporate natural-origin Chinook salmon as broodstock for supportive breeding (conservation) or harvest augmentation purposes. Use of natural-origin fish as broodstock for conservation programs is intended to impart viability benefits to the total, aggregate population by bolstering total and naturally spawning fish abundance, preserving remaining diversity, or improving population spatial structure by extending natural spawning into unused areas. Integration of natural-origin fish for harvest augmentation programs is intended to reduce genetic diversity reduction risks by producing fish that are no more than moderately diverged from the associated, donor natural population. Incorporating natural-origin fish as broodstock for harvest programs produces hatchery fish that are genetically similar to natural-origin fish, reducing risks to the natural population that may result from unintended straying and spawning by unharvested hatchery-origin adults in natural spawning areas. To allow monitoring and evaluation of the performance and effects of programs incorporating natural-origin fish as broodstock, all juvenile fish are marked prior to release with Coded Wire Tags (CWTs) and/or with a clipped adipose fin so that they can be differentiated and accounted for separately from juvenile and returning adult natural-origin fish.

Chinook salmon stocks are artificially propagated through 30 programs in Puget Sound. Currently, the majority of Chinook salmon hatchery programs produce fall-run (also called summer/fall) stocks for fisheries harvest augmentation purposes. Supplementation programs implemented as conservation measures to recover early returning Chinook salmon operate in the White (Appleby and Keown 1994), Dungeness (Smith and Sele 1995), and North Fork Nooksack rivers, and for summer Chinook salmon on the North Fork Stillaguamish and Elwha Rivers (Fuss and Ashbrook 1995; Myers et al. 1998). Supplementation or reintroduction programs are in operation for early Chinook salmon in the South Fork Nooksack River, fall Chinook salmon in the South Fork Stillaguamish River (Tynan 2010) and spring and late-fall Chinook salmon in the Skokomish River (Redhorse 2014; Speaks 2017).

Conservation hatchery programs, under the PST critical stock program, are currently operating in the Nooksack, Dungeness, and Stillaguamish rivers. A new program is being developed for Mid-Hood Canal. Funding for these programs was included in the PST funding initiative, which NMFS addressed in the consultation on domestic actions associated with implementation of the 2019-2028 PST Agreement (NMFS 2019e). Federal funding appropriated in 2020 and 2021 for the PST funding initiative provides a level of certainty these programs will continue. NMFS previously reviewed both the Dungeness and Stillaguamish programs through a section 7 consultation and approved them under the 4(d) rule for threatened Chinook salmon (NMFS 2016j; 2019a). Review and development of a renewed approach to the Mid-Hood Canal hatchery program is currently ongoing.

Conservation programs are designed to preserve the genetic resources of salmon populations and protect against demographic risks while the factors limiting anadromous fish viability are addressed. In this way, hatchery conservation programs reduce the risk of extinction (NMFS 2005; Ford et al. 2011a). However, hatchery programs that conserve vital genetic resources are not without risk to the natural salmonid populations. These programs can affect the genetic structure and evolutionary trajectory of the natural population that the hatchery program aims to conserve by reducing genetic diversity and fitness (HSRG 2014; NMFS 2014a). More details on how hatchery programs can affect ESA-listed salmon and steelhead can be found in Appendix C of NMFS (2018a), incorporated here by reference, and summarized below.

In addition to the PST critical stock programs, there are new initiatives to increase hatchery production to further enhance the SRKW's prey base. For example, in response to recommendations from the Washington State Southern Resident Killer Whale Task Force (2018), the Washington State Legislature provided ~$13 million of funding "prioritized to increase prey abundance for southern resident orcas" (Engrossed Substitute House Bill 1109) for the 2019-2021 biennium (July 2019 through June 2021). Further, NMFS allocated $5.6 million of the PST federal appropriation for FY20 to increase prey availability for SRKW through regional hatchery production. As a result of the additional funding for hatchery production to support SRKW (FY20 PST funding and 2019-2021 Washington State Legislature funding), over 11.6 million additional hatchery-origin Chinook salmon were released in 2020, just over 6.0 million from Puget Sound, and over 18.3 million additional hatchery-origin Chinook salmon are expected to be released in 2021 relative to the base period considered in NMFS' 2019 biological opinion on domestic actions associated with implementation of the new PST Agreement (NMFS 2021d). For Fiscal Year 2021, Congress has appropriated $39.5 million for activities in support of these activities. (166 Cong. Rec. 12/21/2020). In that assessment of the PST funding initiative (NMFS 2019f), we described our expectations for increased prey abundance for SRKWs through increases in the abundance of age 3-5 Chinook salmon in the times and areas most important to SRKWs. The expectations included increased abundance in inside areas (Puget Sound) in the summer and outside areas (coast) during the winter (Dygert 2018) resulting in a minimum increase of adult fish abundance by 4-5 percent in both inside areas in the summer and coastal areas in the winter.

In 2019, NMFS consulted on impacts to ESA-listed species from several U.S. domestic actions associated with the new PST agreement (NMFS 2019d) including federal funding of a conservation program for critical Puget Sound salmon stocks and SRKW prey enhancement. The

2019 opinion (NMFS 2019d) included a programmatic consultation on the PST funding initiative. In Fiscal Year 2020, Congress appropriated $35.1 million dollars for implementation of U.S. domestic activities associated with implementation of the new PST agreement, of which $5.6 million is being used for increased hatchery production to support prey abundance for SRKW and $13.5 million is being used in support of Puget Sound Critical Stock Conservation and Habitat Restoration and Protection, consistent with the funding initiative. For Fiscal Year 2021, Congress appropriated $39.5 million for activities in support of these activities. (166 Cong. Rec. 12/21/2020). The beneficial effects of these activities (i.e., increases in the abundance of Chinook salmon available as prey to SRKW, hatchery conservation programs to support critical Puget Sound Chinook salmon populations, and improved habitat conditions for those populations) are expected to begin within 3-5 years following implementation. Site or project specific ESA and NEPA coverage for these activities is described in the Environmental Baseline (NMFS 2019d).

The beneficial effects of these activities (i.e., increases in the abundance of Chinook salmon available as prey to SRKW, hatchery conservation programs to support critical Puget Sound Chinook salmon populations, and improved habitat conditions for those populations) have recently begun. Subsequent specific actions (i.e., hatchery production programs) would undergo separate consultations, tiered from the programmatic consultations (NMFS 2019d) to assess effects for site-specific actions. The harvest management provisions of the new Agreement and the appropriations to initiate the conservation activities are in place.

One thing worth noting, is that even under current production (hatchery and wild) there is evidence of density dependence in Puget Sound estuaries. Any additional habitat loss could exacerbate potential density dependent impacts especially with increased hatchery production (Greene et al. 2021)

Harvest

Puget Sound salmon fisheries for Chinook, coho, chum, and Fraser River sockeye and pink salmon are managed by the State of Washington and the Indian tribes with treaty rights to fish in Puget Sound. These fisheries are managed consistent with the provisions of the Pacific Salmon Treaty, an international agreement between the U.S. and Canada, which also governs fisheries in Southeast Alaska (SEAK), the coast of British Columbia, the Washington and Oregon coasts, and the Columbia River. Canadian and SEAK salmon fisheries impact salmon stocks from the states of Washington, Oregon, and Idaho as well as salmon originating in SEAK and Canadian waters. Fisheries off the coast of Washington and Oregon and in inland waters, such as the Puget Sound, harvest salmon originating in the U.S. West Coast and Canadian river systems. The PST provides a framework for the management of salmon fisheries in these U.S. and Canada waters that fall within the PST's geographical scope. The overall purpose of the fishing regimens is to accomplish the conservation, production, and harvest allocation objectives set forth in the PST (https://www.psc.org/publications/pacific-salmon-treaty/). The PST provides for the U.S. and Canada to each manage their own fisheries to achieve domestic conservation and allocation priorities, while remaining within the overall limits agreed to under the PST. In 2018, U.S. and Canadian representatives reached agreement to amend versions of five expiring Chapters of Annex IV (Turner and Reid 2018); both countries have since executed this agreement.

Because the Puget Sound Chinook salmon are listed under the ESA and are subject to management under the PST, objectives for Puget Sound salmon fisheries are designed to be consistent with both of these laws. Generally, objectives for Puget Sound Chinook salmon populations are agreed by the State and tribes, in coordination with NMFS. In recent years, NMFS has consulted with the Bureau of Indian Affairs on that agency's assistance to the tribes in managing Puget Sound fisheries; in the resulting biological opinions NMFS has considered the effects of the proposed state and tribal fisheries for the year on Puget Sound Chinook salmon and SRKW. The most recent opinion was issued in May 2021 concluded the fisheries were not likely to jeopardize Puget Sound Chinook salmon or SRKW, and not likely to adversely modify their critical habitat.

The new 2019-2028 PST Agreement includes reductions in harvest impacts for all Chinook salmon fisheries within its scope and refines the management of sockeye, pink, chum, and coho salmon caught in these areas. The new Agreement includes reductions in the allowable annual catch of Chinook salmon in the SEAK and Canadian West Coast of Vancouver Island and Northern British Columbia fisheries by up to 7.5 and 12.5 percent, respectively, compared to the previous agreement (2008-2019). The level of reduction depends on the Chinook salmon abundance in a particular year. This comes on top of the reductions of 15 and 30 percent for those same fisheries that occurred as a result of the prior 10-year agreement (2009 through 2018). Harvest rates on Chinook salmon stocks caught in southern British Columbia and U.S. salmon fisheries, including those under the jurisdiction of the PFMC are reduced by up to 15 percent from the previous agreement (2009 through 2018). Beginning in January 2020 this will result in an increased proportion of abundances of Chinook salmon migrating to waters more southerly in the U.S. Pacific Coast Region portion of the Exclusive Economic Zone (EEZ) than under prior PST agreements. Although provisions of the updated agreement are complex, they were specifically designed to reduce fishery impacts in all fisheries to respond to conservation concerns for a number of U.S. and Canadian stocks.

In its 2019 opinion on domestic actions related to the 2019-2028 PST Agreement (NMFS 2019e), NMFS assumed that the State of Alaska would manage its SEAK salmon fisheries consistent with the provisions of the Agreement. Using methodology similar to previous biological opinions completed up to that time (e.g. NMFS 2019b), NMFS estimated that the percent reductions of Chinook salmon in inland waters of WA from the SEAK fisheries were expected to range from 0.1 percent to 2.5 percent with the greatest reductions occurring in July – September. Percent reductions in coastal waters of WA and OR from the SEAK fisheries were expected to range from 0.2% to 12.9 percent and similarly the greatest reductions would occur in July – September. Percent reductions from Canadian salmon fisheries were expected to range up to 13.2 percent in coastal waters and up to 12.9 percent in inland waters, with greatest reductions in July to September, and also greater inland water reductions in May-June than Puget Sound or PFMC fisheries (NMFS 2019e).

In 2021, NMFS consulted on the authorization of the West Coast Ocean salmon fisheries through approval of the Pacific Salmon Fishery Management Plan including Amendment 21 and implementation of the Plan through regulations., In November 2020, the PFMC adopted proposed Amendment 21 to reduce the effects of Council-area ocean salmon fisheries on the Chinook salmon prey base of SRKWs. The Amendment, established a threshold representing a low pre-fishing Chinook salmon abundance in the North of Falcon (NOF) area (including the EEZ and state ocean waters), below which the Council and states would implement specific management measures (NMFS 2021a). The NOF abundance threshold is equal to the arithmetic mean of the seven lowest years of time step 1 (TS1, October through April, see (PFMC 2020b) for details) starting abundance from the FRAM model (1994 – 1996, 1998 – 2000 and 2007, updated for validated run size abundance estimates). The threshold based on these years is currently estimated at 966,000 Chinook salmon. Each year, the preseason estimate of Chinook salmon abundance for TS1 for the upcoming fishing year would be compared to the threshold. In years when the projected preseason abundance of Chinook salmon in the NOF area falls below the low abundance threshold, multiple management actions (e.g. quota adjustments and spatial/temporal closures) will be implemented through annual regulations within the NOF area, with the goal of limiting effects of the fishery on SRKWs. NMFS' 2021 biological opinion concluded that the Fisheries Management Plan (FMP) including Amendment 21 is responsive to the abundance of Chinook salmon by requiring that fisheries be designed to meet FMP conservation objectives and addresses the needs of the whales by limiting prey removal from the fisheries in NOF areas during years with low Chinook salmon abundance. Amendment 21 will also reduce the potential for competition between fisheries and SRKW in times and areas where/when the fisheries and whales overlap, and when Chinook salmon abundance is low. Therefore, NMFS concluded the proposed action is not likely to jeopardize the continued existence of the SRKW DPS or destroy or adversely modify its designated or proposed critical habitat (NMFS 2021a). This action may limit the reductions in prey availability by PFMC fisheries on Puget Sound (action area) prey in years with low salmon abundance, compared to the FMP without Amendment 21, but the extent of the impacts of the amendment on inland prey availability specifically is unknown. In years when Chinook salmon abundance is above the threshold, we anticipate similar reductions in prey availability attributed to the PFMC fisheries as that observed in the most recent 10-yr period into the foreseeable future (similar to the approximate 1-3 percent reduction in Chinook salmon abundance in Salish Sea).

Hydropower

A proportion of Chinook salmon from coastal Washington/Oregon and Columbia River likely move into the action area, and could be available to SRKW as prey. In 2020, NMFS consulted on the operation and maintenance of 14 dams and also reservoir projects within the Columbia River System (CRS). Actions analyzed in the biological opinion included both operational (hydropower generation, flood risk management, navigation, and fish passage) and non-operational (habitat improvements, predator management, and hatchery programs) actions and the effects on eight salmon ESUs, five steelhead DPSs, and one DPS of Pacific Eulachon and associated critical habitat (NMFS 2020e). The consultation concluded that the action is not likely to jeopardize the continued existence of the species/populations or destroy or adversely modify critical habitat. The CRS opinion also included NMFS concurrence with the action agencies determination of not likely to adversely affect for the Southern North American green sturgeon DPS and for SRKW and critical habitat. The determination for SRKW considered the potential to affect prey availability through negative effects on the direct survival of juvenile and adult salmonids, including Chinook salmon, through the hydrosystem, however, concluded that any effects to SRKW prey base are insignificant or extremely unlikely because the CRS-funded hatchery production more than offsets any adverse effects of CRS operations and maintenance (NMFS 2020e).

In the Puget Sound, there have been multiple section 7 consultations on dams associated with hydropower operations. The Mud Mountain Dam Operation and Maintenance on the White River near Buckley (NMFS 2014) and the Howard Hanson Dam in the Green River watershed (NMFS 2019c) have each been found to jeopardize ESA-listed fish. These dams are associated with operations including water diversion, hydropower, and flood control. In the case of Mud Mountain and Howard Hanson, the jeopardy finding to PS Chinook salmon posed a secondary threat of jeopardy to SRKW. In each case, modifications to avoid jeopardizing ESA- listed species are being undertaken. A new fish collection facility is operational at the Mud Mountain Dam (White River Basin). Improvements are ongoing to increase the collection efficiency and survival rates, but the facility is expected to improve adult survival and utilization of habitat above the dam. New fish passage is being designed for Howard Hanson Dam and modifications to its water retention and release schedule is being evaluated to benefit salmonid redds and eggs in spawning areas downstream of the dam. The White River FERC license was surrendered as an outcome of that jeopardy opinion, which resulted in a change of ownership with an intent to complete a habitat conservation plan for its water diversion.

Climate Change

The environmental baseline would also include the projected effects of climate change for the time period commensurate with the effects of the proposed action. Mauger et al (2015) predict that circulation in Puget Sound is projected to be affected by declining summer precipitation, increasing sea surface temperatures, shifting streamflow timing, increasing heavy precipitation, and declining snowpack. While these changes are expected to affect mixing between surface and deep waters within Puget Sound, it is unknown how these changes will affect upwelling. Changes in precipitation and streamflow could shift salinity levels in Puget Sound by altering the balance between freshwater inflows and water entering from the North Pacific Ocean. In many areas of Puget Sound, variations in salinity are also the main control on mixing between surface and deep waters. Reduced mixing, due to increased freshwater input at the surface, can reduce phytoplankton growth, impede the supply of nutrients to surface waters, and limit the delivery of dissolved oxygen to deeper waters. Patterns of natural climate variability (e.g., El Niño/La Niña) can also influence Puget Sound circulation via changes in local surface winds, air temperatures, and precipitation.

All three ESA-listed Puget Sound salmonids were classified as highly vulnerable to climate change in a recent climate vulnerability assessment (Crozier et al. 2019). In estuarine environments, the two greatest concerns associated with climate change are rates of sea-level rise and temperature warming (Wainwright and Weitkamp 2013, Limburg et al. 2016). While the effects of climate change-induced ocean acidification on invertebrate species are well known, the direct exposure effects on salmon remains less certain (Crozier et al. 2019).

The world's oceans are becoming more acidic as increased atmospheric CO_2 is absorbed by water. The North Pacific Ocean is already acidic compared to other oceans, making it particularly susceptible to further increases in acidification (Lemmen et al. 2016). Laboratory and field studies of ocean acidification show it has the greatest effects on invertebrates with calcium-carbonate shells, and relatively little direct influence on finfish; see reviews by Haigh et al. (2015) and Mathis et al. (2015). Consequently, the largest impact of ocean acidification on salmon is likely to be its influence on marine food webs, especially its effects on lower trophic levels, which are largely composed of invertebrates such as pteropods, larval crabs, and krill, which play a significant role in some salmon diets (Haigh et al. 2015, Mathis et al. 2015, Wells et al. 2012). Marine invertebrates fill a critical gap between freshwater prey and larval and juvenile marine fishes, supporting juvenile salmon growth during the important early-ocean residence period (Daly et al. 2009, 2014).

Physiological effects of acidification may also impair olfaction, which could hinder homing ability (Munday et al. 2009), along with other developmental effects (Ou et al. 2015). Although a recent review of ocean acidification studies on fish has called into question many of the behavioral effects of ocean acidification (Clark et al. 2020). Using the criteria of Morrison et al. (2015) for scoring, PS Chinook salmon, HCSR chum salmon, and PS steelhead had low-to-moderate sensitivity to ocean acidification (Crozier et al. 2019).

The same document states that “sea level rise is projected to expand the area of some tidal wetlands in Puget Sound but reduce the area of others, as water depths increase and new areas become submerged. For example, the area covered by salt marsh is projected to increase, while tidal freshwater marsh area is projected to decrease. Rising seas will also accelerate the eroding effect of waves and surge, causing unprotected beaches and bluffs to recede more rapidly. The rate of sea level rise in Puget Sound depends both on how much global sea level rises and on regionally-specific factors such as ocean currents, wind patterns, and the distribution of global and regional glacier melt. These factors can result in higher or lower amounts of regional sea level rise (or even short-term periods of decline) relative to global trends, depending on the rate and direction of change in regional factors affecting sea level” (Mauger et al. 2015).

2.5. Effects of the Action

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

The effects of the Corps’ issuance of permits under this programmatic action will include effects ranging from temporary (typically related to the impacts of construction activity), to persistent and intermittent (from the use or operation of the permitted structures, including impacts from associated vessel use), to enduring (from effects of the structures on the environment and their impacts on habitat features that might be diminished).

2.5.1 General Effects

Program Administration

The Corps will ensure the appropriate design criteria are incorporated into all phases of design for each authorized project. Following review of project submittal, the Corps will provide NMFS with the information and obtain verification from NMFS as described in the proposed action. The verification step ensures projects meet all the applicable design criteria and general construction measures.

As an additional program-level check on the continuing effects of the action, the Corps and NMFS will meet at least annually to review implementation of the programmatic action and opportunities to improve conservation, or make the program overall more effective or efficient. Application of the proposed design criteria and the requirement to avoid net loss of nearshore habitat quality will ensure projects carried out under SSNP will not lead to a long-term loss of conservation for listed species and critical habitat.

Conservation Offsets

The requirement to offset long-term impacts on the quality of nearshore habitat in the Salish Sea is a key feature of SSNP. The following activities result in long-term loss of nearshore habitat quality and thus require conservation offsets:

- PDC #2 Utilities. New footings for relocated transmission lines resulting in a loss of nearshore habitat will require conservation debits.
- PDC #4 Shoreline modification
- PDC #5 Expand or install a new in-water or overwater structure
- PDC #6 Repair or replace an existing structure
- PDC #9 Dredging for vessel access

By requiring offsets, SSNP ensures no net-loss of nearshore habitat quality over time.

Activities carried out to achieve conservation offsets (Program Administration #8) are likely to have some short-term impacts, but none of those impacts will have long-term adverse effects on listed species nor will they be severe enough to impair the ability of habitat to support recovery. The frequency of disturbance caused by these actions will usually be limited to a single event or, at most, a few projects within the same area.

All of the activities intended to achieve offsets are designed to have long-term beneficial effects to species and critical habitat. These activities are reasonably certain to lead to some degree of ecological recovery, including the establishment or restoration of environmental conditions associated with functional nearshore habitat. Many of the activities qualifying for conservation offsets would be identical to the restoration activities included as part of the programmatic action for SSNP. The effects of these activities on listed fish and their habitat are discussed in detail below. The removal of over-water structures reduces shade and decreases predation on juvenile salmonids. Removal of in-water structures such as treated-wood piles also removes habitat for piscine predators and eliminates persistent sources of contaminants. The purchases of conservation bank credits will lead to improved habitat quality, but in some cases, the improvement may be off-site or out-of-kind. Similarly, contributions to in-lieu fee programs generally result in habitat improvements but the improvement can be delayed and is typically off-site.

NMFS will review each project requiring conservation offsets. This check will ensure that the proposed offsets meet the requirements of Program Administration Criterion #8 and are sufficient to compensate for the associated adverse impact.

2.5.2 Temporary Effects During Construction[56]

Authorization of construction of projects covered under the SSNP programmatic action, despite the use of required GCMs to reduce or minimize construction impacts, will include (a) water quality reductions; (b) increases in re-suspended contaminants; (c) increased noise in the aquatic environment; (d) reduction of prey/forage (benthic prey, forage fish, prey fishes); and (e) impacts from drilling and boring. Additionally, dredging activities can entrain fish.

Frequency of Effects from Near and In-Water Construction
The Corps provided information on the expected frequency of activities covered under the proposed action. Based on that information, as well as our own evaluation of projects we have received a request to consult on from the Corps over the last few years, we expect a maximum of 320 projects involving in or near-water construction to be implemented per year under SSNP (Table 1). Based on that same analysis, we expect these projects would likely result in the repair, replacement, or installation of up to approximately 24,000 linear feet of shoreline armoring, 14,000 piles, 220,000 square feet of overwater and in-water structures (Table 3). The projects would be spread across a large geography in the Salish Sea although there is expected to be some geographic clumping of projects near urban areas such as Seattle, Tacoma, Bellingham, Anacortes, and Port Townsend.

Duration of Effects from Near and In-Water Construction
The direct effects of construction such as elevated suspended sediment and increased risk of injury or death from contact with heavy equipment occur continuously while construction is underway. This can vary from a few hours to a few months depending on the scale of the project. For most projects, the construction phase lasts for a few days to a few weeks. Most projects involve a single construction phase. Some projects require an initial construction phase followed by periodic maintenance.[57]

The indirect effects of construction such as riparian and shoreline disturbance typically last for a year or two until the project site recovers from the disturbance. During this time, habitat quality will remain impaired to some extent.

Inwater work and fish capture and release
Effects from in-water work are generally avoided and minimized through use of: (1) In-water work isolation strategies that often involve capture and release of trapped fish and other aquatic

[56] Although the effects of dredging can be similar to the effects of in-water construction, dredging is a discreet activity and a separate, comprehensive analysis of dredging can be found below in section 2.5.5.
[57] Any effects caused by a future, yet-to-be requested permit to conduct maintenance or repair actions are not considered in this consultation.

invertebrates, and (2) performing the work during work windows when the fewest individuals of a species are present. Capturing and handling fish causes them stress, though they typically recover fairly rapidly from the process and therefore the overall effects of the procedure are generally short-lived (NMFS 2002). The primary contributing factors to stress and death from handling are differences in water temperatures (between the river and wherever the fish are held), dissolved oxygen conditions, the amount of time that fish are held out of the water, and physical trauma. Stress on salmonids increases rapidly from handling if the water temperature exceeds 18ºC (64ºF) or dissolved oxygen is below saturation

The general construction measure proposed for fish capture and release, use of pump-intake screens during the de-watering phase, and fish passage around the isolation area are based on standard NMFS guidance to reduce the adverse effects of these activities (NMFS 2022). Key conservation measures in the guidance such as limiting work during times of high-water temperatures significantly reduces mortality that can occur during work area isolation. Use of properly sized screens during water withdrawal can reduce or nearly eliminate injury or death of fish caused by entrainment.

Water Quality

Water quality is likely to be affected during in-water work. Water quality effects during construction are likely to include turbid conditions, decreased dissolved oxygen, and suspension of contaminated materials as described below. In-water construction is proposed to occur during in-water work windows established by WDFW. This helps ensure that fish, particularly salmonid, presence at construction site is low as compared to other times of the year. This helps minimize the number of fish exposed to effects on water quality.

Turbidity

Turbid conditions can be created during pile installation, pile removal, boat ramp repairs, excavation to install, replace or repair bulkheads, and other activities involving in- or near-water construction. In estuaries, state water quality regulations (WAC173-201A-400) establish a mixing zone of 200 feet plus the depth of water over the discharge port(s) as measured during mean lower low water. For non-dredging activities it is expected that during the days that construction activities occur in the water, elevated suspended sediment levels could occur within this mixing zone.

Reduced Dissolved Oxygen (DO)

Suspension of anoxic sediment compounds during in water work can result in reduced DO in the water column within the mixing zone area as the sediments oxidize. Based on a review of six studies on the effects of suspended sediment on DO levels, LaSalle (1988) concluded that, when relatively low levels of suspended material are generated and counterbalancing factors such as flushing exist, anticipated DO depletion around in water work activities will be minimal. High levels of turbidity could have contemporaneous reduction in dissolved oxygen within the same affected area.

For non-dredging activities, as with suspended sediments, reduced DO is not expected to exceed the established mixing zone of 200 feet plus the depth of water over the discharge port(s) as measured during mean lower low water.

Under the proposed action, erosion control measures will be applied to any project that involves near or in-water construction. These measures constrain and secure the site against erosion and inundation during high flow events. This minimizes the amount of fine sediments entering nearshore marine areas, estuaries, and river (up to the salt wedge). The selection of properly sized heavy and equipped heavy machinery minimizes soil disturbance.

<u>Incidental Discharge of Contaminants</u>
Barges and tugs will be used to construct many of the projects as well as some work associated with the actions to achieve conservation offsets. Significant discharge of hydraulic fluid, oils, or fuels from construction equipment would constitute an unlawful discharge and are not considered here. However, the operation of these vessels at each location are likely to have small incidental discharges caused by drippage from engines, which will introduce very small amounts of fuels, oils, or lubricants into the water. Incidental discharge of oils or fuels, and polycyclic aromatic hydrocarbons (PAHs) may also result from exhaust from these kinds of construction vessels, or from accidental introduction of oils or fuels from equipment in contact with water. These incidental discharges are likely at any site where such vessels are used to stage construction equipment or materials. We expect these PAHs and other contaminants to be introduced into the water column during and immediately following the proposed activity. Because these materials can disperse quickly, they can become quite widespread at very low concentration. PAHs from the exhaust of these vessels have a similar pattern of dispersal. The environmental fate of each type of PAH depends on its molecular weight. In surface water, PAHs can volatilize, photolyze, oxidize, biodegrade, bind to suspended particles or sediments, or accumulate in aquatic organisms, with bioconcentration factors often in the 10-10,000 range.

<u>Re-suspended Contaminants</u>
In some project locations, in water work is likely to include resuspension of contaminated sediments, including the incidental discharge of contaminated materials when creosote treated wood materials are being removed. Creosote-treated piles contaminate the surrounding sediment up to two meters away with PAHs (Evans et al. 2009). The removal of the creosote-treated piles mobilizes these PAHs into the surrounding water and sediments (Smith et al. 2008; Parametrix 2011). Projects can also release PAHs directly from creosote-treated timber during the demolition of overwater timber and if any of the piles break during removal (Parametrix 2011). The concentration of PAHs released into surface water rapidly dilutes. Smith et al. (2008) reported concentrations of total PAHs of 101.8 μg/l 30 seconds after creosote-pile removal and 22.7 μg/l 60 seconds after. However, PAH levels in the sediment after pile removal can remain high for six months or more (Smith et al. 2008). Romberg (2005) found a major reduction in sediment PAH levels three years after pile removal contaminated an adjacent sediment cap. For some projects, removal of creosote timber piles will reduce leaching of chemical compounds into nearshore and marine sediments, which can cause toxic conditions for organisms that use these areas (DNR 2014). The proposed action includes specific measures in general construction measures 9 and 10, designed to minimize the introduction of contaminants from plie removal.

For non-dredging activities, as with suspended sediments, re-suspended contaminants are not expected to be detectable beyond background levels beyond the established mixing zone of 200 feet plus the depth of water over the discharge port(s) as measured during mean lower low water.

Noise in aquatic habitat generated during in-water work

Noise is expected as a short-term consequence from construction activities during in-water work. Noise will result from pile driving and vessel/barge use as described below.

Pile Driving.

Pile driving is frequently required for the proposed activity categories involving overwater structures. Pile driving can cause high levels of underwater sound; the use of a confined or unconfined bubble curtain results in only a 10dB reduction. Pile driving can significantly increase sound waves in the aquatic habitat. The sound pressure levels from pile driving and extraction will occur contemporaneous with the work and radiate outward; the effect attenuates with distance. Cumulative sound exposure level (SEL) is a measure of the sound energy integrated across all of the pile strikes. The Equal Energy Hypothesis, described by NMFS (2007b), is used as a basis for calculating cumulative SEL (cSEL). The number of pile strikes is estimated per continuous work period. This approach defines a work period as all the pile driving between 12-hour breaks. NMFS uses the practical spreading model to calculate transmission loss, and define the area affected. Both vibratory noise and impact noise can create sufficient disturbance to affect the suitability of habitat from a behavioral and physiological sense for listed species.

Construction Vessels/Barge use.

Barges and tugs will be used to construct many overwater structures and are expected to have adverse effects similar to those articulated for vessel impacts in the Environmental Baseline section of this Opinion. Barges will increase the amount of noise in an area surrounding each construction site and their transit paths. General construction measure 12 includes measures designed to limit the impacts of barge use. For instance, if barrages are present at a project site for longer than 24 hours, steps must be taken to ensure the barge does not ground out.

Barges are similar to over-water structures when positioned/anchored at the same location after a few hours. Barges obscure 100 percent of natural light and may draw several feet of water. They occupy space in the water column and create overwater cover. This may lead to a temporary impediment to fish passage and an increase in cover for piscivorous fish that may consume listed salmonids. Barges can also serve as attractive loafing/roosting habitat for avian predators of juvenile salmonids. The intensity of effects, in all of these cases is associated with barge size, in addition to the moorage depth, and moorage location relative to the shoreline. These effects are discussed in further detail the “In-Water and Over-Water Structures and Related Activities” effects section, below.

Tug boats tow the barges to and from the construction site and position the barges for the construction activities. At times, smaller skiff type boats (less than 30 feet in length) are also on site to perform various functions in support of construction. The effects of boat use are discussed in the “Enduring Effects of In-water, Overwater, and Nearshore Structures” effects section, below.

Barge use and positioning (especially if done by tugboat) can cause localized scour if operating in shallow water (i.e., <20 feet). Localized scour can result in reduction of benthic aquatic vegetation and macroinvertebrates. These effects are temporary, typically lasting for the duration of barge mooring in a particular location. Effects resulting from scour may last for several months, but habitat quality will eventually fully recover.

Benthic Communities and Forage Species Diminishment.
Areas where sediment is disturbed by pile driving, pile removal, dredging, or other in-or near water work such as boat ramp or bulkhead construction, repair, or replacement, and from vessels in shallow water areas to facilitate construction, will disturb and diminish benthic prey communities. In areas where suspended sediment settles on the bottom, some smothering can occur which also disrupts the benthic communities. The speed of recovery by benthic communities is affected by several factors, including the intensity of the disturbance, with greater disturbance increasing the time to recovery (Dernie et al. 2003). Additionally, the ability of a disturbed site to recolonize is affected by whether or not adjacent benthic communities are nearby that can re-seed the affected area. Thus, recovery can range from several weeks to many months.

Drilling and Boring.
Drilling operations as a means of soil testing may themselves cause erosion, sedimentation from drilling mud, or other temporary site disturbances. Similarly, untreated drilling fluids sometimes travel along a subsurface soil layer and exit in a stream or wetland and degrade water quality. Air rotary drilling produces dust, flying sand-sized rock particles, foaming additives, and fine water spray. The distances that cuttings and liquids (e.g., water, foaming additives) are ejected out of the boring depend on the size of the drilling equipment. Unrestrained, larger equipment will disperse particles up to six meters, while smaller equipment will typically expel particles up to three meters. As with any heavy equipment, drilling rigs are subject to accidental spills of fuel, bentonite, lubricants, hydraulic fluid and other contaminants that, if unconfined, may harm the riparian zone or aquatic habitats. SNNP general construction measure 5 requires measures to reduce or prevent impacts of drilling, boring, and potential frac-outs.

2.5.3 Intermittent Effects From Use and Maintenance of Overwater Structures

The proposed action for SSNP includes authorization of the construction of new as well as the repair and replacement of several types of overwater structures. These structures include piers, ramps, and floats, wharfs, mooring buoys, marina structures. These overwater structures will generate several types of episodic habitat effects, which will occur while the structures are present in the environment: (a) water quality reductions from vessel use and discharge of stormwater from pollution generating impervious surfaces; (b) noise from vessel operation; (c) scour from vessel operation. Each are episodic and persistent effects, coextensive with the respective design lives of the new, expanded, repaired or replaced wharfs, piers, docks, floats, and structures.

Impacts from future maintenance that does not require a Corps permit would also be considered effects of the action. These effects are expected to be relatively minor as they are unlikely to include in-water construction.

Water Quality
Overwater structures generally cause reduction in water quality stemming from vessels and/or unmanaged stormwater from the surface of wharves or upland areas. Pollutants in the post-

construction stormwater runoff from projects that create new impervious surfaces, or repair or replace existing impervious surfaces, or otherwise extend the life of impervious surface will come from many diffuse sources, but is most likely to occur at large commercial or municipal facilities with larger areas of impervious surface that supports vehicular traffic. The runoff itself comes from rainfall or snowmelt moving over these surfaces, where it picks up and carries away natural and anthropogenic pollutants, finally depositing them into coastal waters, (Dressing et al. 2016).

Pollutants in post-construction stormwater runoff typically include:

- Excess fertilizers, herbicides, insecticides and sediment from landscaping areas;
- Oil, grease, PAHs and other toxic chemicals from roads and parking areas used by motor vehicles;
- Bacteria and nutrients from pet wastes and faulty septic systems;
- Metals (arsenic, copper, chromium, lead, mercury, and nickel) and other pollutants from the decay of building and other infrastructure;
- Atmospheric deposition from surrounding land uses; and
- Erosion of sediment and attached pollutants due to hydromodification.

(Buckler and Granato 1999; Colman et al. 2001; Driscoll et al. 1990; Kayhanian et al. 2003; Van Metre et al. 2005). Pollutants will become more concentrated on impervious surfaces until they either degrade in place or are transported by wind, precipitation, or active site management. Although stormwater discharge from most proposed projects will be small in comparison to the flow of the nearby waterways, it will have an incremental impact on pollutant levels within the action area. The adverse effects of stormwater runoff from the projects authorized by the the Corps will occur primarily at the basin scale due to persistent additions of pollutants or the compounding effects of many environmental processes.

The following brief summaries from toxicological profiles (ATSDR 1995; ATSDR 2004a; ATSDR 2004b; ATSDR 2005; ATSDR 2007) show how the environmental fate of each contaminant and the subsequent exposure of listed species and critical habitats varies widely, depending on the transport and partitioning mechanisms affecting that contaminant, and the impossibility of linking a particular discharge to specific water body impairment (NRC 2009):

- DDT and its metabolites, dichlorodiphenyldichloroethylene (DDE) and dichlorodiphenyltrichloroethane (DDD) (all collectively referred to as DDx) may be transported from one medium to another by the processes of solubilization, adsorption, remobilization, bioaccumulation, and volatilization. In addition, DDx can be transported within a medium by currents, wind, and diffusion. These chemicals are only slightly soluble in water, therefore loss of these compounds in runoff is primarily due to transport of particulate matter to which these compounds are bound. For example, DDx have been found to fractionate and concentrate on the organic material that is transported with the clay fraction of the wash load in runoff. Sediment is the sink for DDx released into water where it can remain available for ingestion by organisms, such as bottom feeders, for many years.

- The environmental fate of each type of PAH depends on its molecular weight. In surface water, PAHs can volatilize, photolyze, oxidize, biodegrade, bind to suspended particles or sediments, or accumulate in aquatic organisms, with bioconcentration factors often in the 10-10,000 range. In sediments, PAHs can biodegrade or accumulate in aquatic organisms or non-living organic matter. Some evaporate into the air from the surface but most do not easily dissolve in water, some evaporate into the air from surface waters, but most stick to solid particles and settle into sediments. Changes in pH and hardness may increase or decrease the toxicity of PAHs, and the variables of organic decay further complicate their environmental pathway (Santore et al. 2001).
- PCBs are globally transported and present in all media. Atmospheric transport is the most important mechanism for global dispersion of PCBs. PCBs are physically removed from the atmosphere by wet deposition (i.e., rain and snow scavenging of vapors and aerosols); by dry deposition of aerosols; and by vapor adsorption at the air-water, air-soil, and air-plant interfaces. The dominant source of PCBs to surface waters is atmospheric deposition; however, redissolution of sediment-bound PCBs also accounts for water concentrations. PCBs in water are transported by diffusion and currents. PCBs are removed from the water column by sorption to suspended solids and sediments as well as from volatilization from water surfaces. Higher chlorinated congeners are more likely to sorb, while lower chlorinated congeners are more likely to volatilize. PCBs also leave the water column by concentrating in biota. PCBs accumulate more in higher trophic levels through the consumption of contaminated food.
- Due to analytical limitations, investigators rarely identify the form of a metal present in the environment. Nonetheless, much of the copper discharged into waterways is in particulate matter that settles out. In the water column and in sediments, copper adsorbs to organic matter, hydrous iron and manganese oxides, and clay. In the water column, a significant fraction of the copper is adsorbed within the first hour of introduction, and in most cases, equilibrium is obtained within 24 hours.
- For zinc, sorption onto hydrous iron and manganese oxides, clay minerals, and organic material is the dominant reaction, resulting in the enrichment of zinc in suspended and bed sediments. The efficiency of these materials in removing zinc from solution varies according to their concentrations, pH, redox potential, salinity, nature and concentrations of complexing ligands, cation exchange capacity, and the concentration of zinc. Precipitation of soluble zinc compounds appears to be significant only under reducing conditions in highly polluted water.
- A significant fraction of lead carried by river water occurs in an undissolved form, which can consist of colloidal particles or larger undissolved particles of lead carbonate, lead oxide, lead hydroxide, or other lead compounds incorporated in other components of surface particulate matter from runoff. Lead may occur either adsorbed ions or surface coatings on sediment mineral particles, or it may be carried as a part of suspended living or nonliving organic matter in water. The ratio of lead in suspended solids to lead in dissolved form has been found to vary from 4:1 in rural streams to 27:1 in urban streams. Sorption of lead to polar particulate matter in freshwater and estuarine environments is an important process for the removal of lead from these surface waters.

Recent studies have shown that coho salmon show high rates of pre-spawning mortality when exposed to chemicals (6PPD-quinone) that leach from tires (McIntyre et al. 2015). Researchers have recently identified a tire rubber antioxidant as the cause (Tian et al. 2020). Although Chinook did not experience the same level of mortality, tire leachate is still a concern for all salmonids. Traffic residue also contains many unregulated toxic chemicals such as pharmaceuticals, polycyclic aromatic hydrocarbons (PAHs), fire retardants, and emissions that have been linked to deformities, injury and/or death of salmonids and other fish (Trudeau 2017; Young et al. 2018).

Pollutants travel long distances when in solution, adsorbed to suspended particles, or else they are retained in sediments, particularly clay and silt, which can only be deposited in areas of reduced water velocity until they are mobilized and transported by future sediment moving flows (Alpers et al. 2000a; Alpers et al. 2000b; Anderson et al. 1996). Santore et al. (2001) indicates that the presence of natural organic matter and changes in pH and hardness affect the potential for toxicity (both increase and decrease). Additionally, organics (living and dead) can adsorb and absorb other pollutants such as PAHs. The variables of organic decay further complicate the path and cycle of pollutants.

General construction measure 13 requires a comprehensive approach to stormwater management, addressing both the quality and quantity of stormwater discharged from impervious surfaces. This approach will greatly reduce, but not eliminate the level of contaminants in discharged stormwater.

<u>Noise from commercial and recreational vessel operation</u>

During consultation, NMFS identified vessel use associated with new, repaired, and replaced piers, wharfs, marinas, docks, and boat ramps as a consequence of the programmatic action. Although vessel use is already common in the general vicinity of existing structures, a level of vessel use that is commensurate with the life of the structure attributable to the proposed action will be a consequence of the underlying action of repairing, replacing, or expanding existing docks, piers, wharfs, ramps, floats and marinas. In addition, we assume new vessel use will occur in association with new or expanded overwater structures. In many cases, vessel traffic caused by the proposed action will often by operated by third parties.

Similar to what is described in the section on vessel noise from construction vessels, above, underwater sound from boat motors is known to cause physiological stress to fish and marine mammals. Recreational and commercial vessel activity is another known cause of underwater sound. Vessel sound effects are expected intermittently for short periods (minutes) with each episode of use for recreational vessels, and NMFS anticipates these effects will be primarily during late spring, summer, and early fall when leisure boating typically occurs. For vessels using commercial structures, such episodic noise is expected year-round.

<u>Scour of nearshore areas from prop wash</u>

Associated commercial and recreational vessel use adversely affects submerged aquatic vegetation (SAV) where it is present, and inhibits its recruitment where not present, by frequently churning water and sediment in the shallow water environment. Additionally, the turbidity from boat propeller wash decreases light levels (Eriksson et al. 2004). Shafer (1999; 2002) provides background information on the light requirements of seagrasses and documents the effects of reduced light availability on seagrass biomass and density, growth, and morphology. Decreased ambient light typically results in lower overall productivity, which is ultimately reflected in lower shoot density and biomass (Shafer 1999; 2002). Areas where sediment is routinely disturbed by prop wash will also experience repeated disruption of benthic prey communities, suppressing this forage source. Consistent with our analytical approach in this Opinion, these impacts are considered coextensive with the effects of the repaired, replaced or new OWS themselves (see *Response to Habitat Disruptions from In-Water and Overwater Structures* below).

2.5.4 Enduring Effects of In-water, Overwater, and Nearshore Structures

The proposed action for SSNP includes authorization of the construction of new or expanded, as well as the repair and replacement of several types of overwater, in-water, and nearshore structures. In- and overwater structures and nearshore structures influence habitat functions and processes for the duration of the time they are present in habitat areas. The effects include: (a) altered predator/prey dynamics; (b) disrupted migration; and (c) modified shore processes related to bank armoring. These effects are chronic, persistent, and co-extensive with the life of the structure.

Predator/prey dynamics

Overwater structures (OWSs) adversely affect SAV, if present, and inhibit the establishment of SAV where absent, by creating enduringly shaded areas. (Kelty and Bliven 2003). Decreased ambient light typically results in lower overall productivity, which is ultimately reflected in lower shoot density and biomass (Shafer 1999; 2002). In contrast to other studies in the Pacific Northwest, Shafer (2002) specifically considers small residential OWS and states, "much of the research conducted in Puget Sound has been focused on the impacts related to the construction and operation of large ferry terminals. Although some of the results of these studies may also be applicable to small, single-family docks, there are issues of size, scale, and frequency of use that may require separate sets of standards or guidelines. Notwithstanding, any overwater structure, however small, is likely to alter the marine environment."

Fresh et al. (2006a) researched the effects of grating in residential floats on eelgrass. They reported a statistically significant decline in eelgrass shoot density underneath six of the eleven studied floats in northern Puget Sound. However, the physiological pathways that result in the reduction in shoot density and biomass from shading applies to all SAV. Thus, it is reasonable to assume that shading from OWS adversely affects all SAV.

In addition to reduced SAV biomass and shoot density, shading also has been shown to be correlated with reduced density of the epibenthic forage under OWS's (Haas et al. 2002, Cordell et al. 2017). While the reduction in light and SAV were likely a cause for the reduction in epibenthos, changes in grain size due to boat action and current alteration also may have contributed (Haas et al. 2002). Eelgrass is a substrate for herring spawning, and herring spawn is Chinook salmon forage species. The likely incremental reduction in epibenthic prey associated with OWS projects will reduce forage for listed fish.

SSNP activity design criteria limit the effects of OWSs predator/prey dynamics. For instance, grating requirements for residential and marina OWSs ensures that shading is reduced by allowing some light to penetrate below the OWS. Additionally, skirting and other continuous protective bumper material that may impede light penetration beneath an overwater structure may not extend below the bottom edge of a float frame or pier, further reducing the creation of shade. The proposed action does not include new covered OWS (e.g., boat house, boat garage, storage shed) which would create complete shade underneath the structure. Conservation offsets are required to compensate for the effects on predator/prey dynamics caused by new and repaired/replaced of OWSs.

Obstructions in migration areas

Juvenile Chinook and juvenile HCSR chum migrate along shallow nearshore habitats, and OWS's will disrupt their migration and increase their predation risk. Most juvenile Chinook and juvenile HCSR chum will encounter some OWSs during their out-migration. We cannot estimate the number of individuals that will experience migration delays and increased predation risk from the proposed OWSs. Adult Chinook, adult and juvenile steelhead, and adult chum, do not explicitly rely on shallow nearshore habitats; OWS are not considered to be a significant obstruction to their movements.

Overwater structures cause delays in migration for PS Chinook salmon from disorientation, fish school dispersal (resulting in a loss of refugia), and altered migration routes (Simenstad 1999). Juvenile salmonids stop at the edge of the structures and avoid swimming into their shadow or underneath them (Heiser and Finn 1970; Able et al. 1998; Simenstad 1988; Southard et al. 2006; Toft et al. 2013; Ono 2010). Swimming around structures lengthens the migration distance and is correlated with increased mortality. Anderson et al. (2005) found migratory travel distance rather than travel time or migration velocity has the greatest influence on the survival of juvenile spring Chinook salmon migrating through the Snake River.

Juvenile salmon, in both the marine nearshore and in freshwater, migrate along the edge of shadows rather than through them (Nightingale and Simenstad 2001b; Southard et al. 2006; Celedonia et al. 2008a; Celedonia et al. 2008b; Moore et al. 2013; Munsch et al. 2014). In freshwater, about three-quarters of migrating Columbia River fall Chinook salmon smolts avoided a covered channel and selected an uncovered channel when presented with a choice in an experimental flume setup (Kemp et al. 2005). In Lake Washington, actively migrating juvenile Chinook salmon swam around structures through deeper water rather than swimming underneath a structure (Celedonia et al. 2008b). Structure width, light conditions, water depth, and presence of macrophytes influenced the degree of avoidance. Juvenile Chinook salmon were less hesitant to pass beneath narrower structures (Celedonia et al. 2008b).

In the marine nearshore, there is substantial evidence that OWS impede the nearshore movements of juvenile salmonids and reduced feeding rates for those fish that do utilize OWS (Heiser and Finn 1970; Able et al. 1998; Simenstad 1999; Southard et al. 2006; Toft et al. 2007; Moore et al. 2013, Munsch et al. 2014, see ref). In the Puget Sound nearshore, 35-millimeter to 45-millimeter juvenile chum and pink salmon were reluctant to pass under docks (Heiser and Finn 1970). Southard et al. (2006) snorkeled underneath ferry terminals and found that juvenile salmon were not underneath the terminals at high tides when the water was closer to the structure, but only moved underneath the terminals at low tides when there was more light penetrating the edges. Moore et al. (2013) concluded in their study that the Hood Canal Bridge may attract PS steelhead smolts to its shade while also inhibiting passage by disrupting Hood

Canal currents. They found this delayed migration, for a species whose juveniles typically migrate rapidly out to the open ocean, likely resulted in steelhead becoming more susceptible to predation by harbor seals and avian predators at the bridge. These findings show that overwater-structures can disrupt juvenile salmonid migration in the Puget Sound nearshore.

An implication of juvenile salmon avoiding OWS is that some of them will swim around the structure (Nightingale and Simenstad 2001b). This behavioral modification will cause them to temporarily utilize deeper habitat, thereby exposing them to increased piscivorous predation. Hesitating upon first encountering the structure, as discussed, also exposes salmonids to avian predators that may use the floating structures as perches. Typical piscivorous juvenile salmonid predators, such as flatfish, sculpin, and larger juvenile salmonids, being larger than their prey, generally avoid the shallowest nearshore waters that outmigrant juvenile salmonids prefer—especially in the earliest periods of their marine residency. When juvenile salmonids temporarily leave the relative safety of the shallow water, their risk to being preyed upon by other fish increases. This has been shown in the marine environment where juvenile salmonid consumption by piscivorous predators increased fivefold when juvenile pink salmon were forced to leave the shallow nearshore (Willette 2001). Elevated pinniped predation rates have been documented at major anthropogenic structures that inhibit movement and cause unnaturally large aggregations of salmonid species (Jeffries and Scordino 1997, Keefer et al. 2012, Moore et al. 2013). The most widely known and intensely studied pinniped/salmonid conflict is California sea lion predation on winter steelhead at the Ballard Locks in Seattle, Washington (Jeffries and Scordino 1997). Although California sea lions first began appearing in the Ballard Locks area on a somewhat regular basis in 1980, their predation on steelhead was not viewed as a resource conflict until 1985, when a significant decline in the wild winter steelhead spawning escapement was noted (Gearin et al. 1996). Subsequent scientific studies documented that sea lions were removing significant numbers of adult steelhead that were returning to the Lake Washington system to spawn (Scordino and Pfeifer 1993).

Dams have also been shown to create favorable conditions for piscine predators to congregate in slow-moving reservoir currents where they exploit migrating salmon and steelhead smolts. Adult salmon later congregate on their upriver migrations as they attempt to pass over Bonneville Dam, attracting increasing numbers of Eumetopias Jubatus and Zalophus Californianus (Stellar and California sea lions) that consume between 0.4–4.9 percent of the upriver salmon run each year (Keefer et al. 2012).

The number of wild steelhead consumed by sea lions between 1986 and 1992 was 42-65 percent of the total run (NMFS 1995). In spite of intense sea lion deterrence and mitigation efforts from 1985 to 1995, a small number of sea lions returned to the Ballard Locks area each season and preyed on steelhead (Scordino and Pfeifer 1993). The observations of steelhead predation by California sea lions at the Ballard Locks show a significant proportion (65 percent) of an entire salmonid run can be consumed by sea lions (Scordino and Pfeifer 1993) and clearly demonstrates that the combination of high local-predator abundance during salmonid migrations, restricted passage, and depressed fish stocks can result in significant impacts on local salmonid populations (NMFS 1995).

Another study was conducted by Moore et al. 2013 at the Hood Canal Bridge, a floating structure that extends 3.6 meters underwater and forms a partial barrier for steelhead migrating from Hood Canal to the Pacific Ocean. The authors found more steelhead smolt mortality events occurred within the vicinity of the Hood Canal Bridge than at any other site that was monitored from 2006 through 2010. Smolts that passed by the Hood Canal Bridge receiver array behaved differently than those migrating past similarly spaced receiver arrays inside the Hood Canal, in Puget Sound, and in the Strait of Juan de Fuca. The observed changes in behavior was potentially a result of one or several interacting physical, ecological or environmental factors altered by the bridge structure. Mortalities are likely caused by predation by a marine mammal, inferred from movement patterns recorded on Hood Canal Bridge receivers that would be atypical of surviving steelhead smolts or tags consumed by avian predators (Moore et al. 2013). Longer migration times and paths are likely to result in a higher density of smolts near the bridge in relation to other sites along the migration route, possibly inducing an aggregative predator response to steelhead smolts (Moore et al. 2013).

Further, swimming around OWS lengthens the salmonid migration route, which has been shown to be correlated to increased mortality. Migratory travel distance rather than travel time or migration velocity has been shown to have the greatest influence on survival of juvenile spring Chinook salmon migrating through the Snake River (Anderson et al. 2005). In summary, NMFS anticipates that the increase in migratory path length from swimming around OWS as well as the increased exposure to piscivorous predators in deeper water likely will result in proportionally increased juvenile PS Chinook salmon and HCSR chum mortality. Except for the Hood Canal Bridge example where the pontoons span roughly 95 percent of the width of the Hood Canal at low tide, PS steelhead do not tend to be nearshore dependent and thus the presence of these structures is unlikely to affect their behavior.

SSNP requires multiple design criteria to limit the impacts of OWS on salmonid migration. Requirements for grated decking allow light transmission below residential OWSs reducing impacts of shading. Skirting and other continuous protective bumper material structure may not extend below the bottom edge of a float frame or pier, further reducing shading. New OWS that create complete shade are not proposed for authorization under SSNP. Repair or replacement of commercial or industrial OWSs that create complete shade is proposed under SSNP. However, conservation offsets are required to compensate for the migration impacts caused by OWSs that are covered under SSNP.

Disrupted Shore Processes

The proposed action allows for shoreline modification including marine bulkheads. The effects that these structures exert on habitat features and functions also will persist for the same duration. The impacts of hard armor along shorelines are well documented. Armoring of the nearshore can reduce or eliminate shallow water habitats through the disruption of sediment sources and sediment transport. Bulkheads, whether new, repaired, or replacement are expected to result in a higher rate of beach erosion water ward of the armoring from higher wave energy compared to a natural shoreline. This leads to beach lowering, coarsening of substrates, increases in sediment temperature, and decreased SAV, leading to reductions in primary productivity and invertebrate density within the intertidal and nearshore environment (Bilkovic and Roggero 2008; Fresh et al. 2011; Morley et al. 2012; Dethier et al. 2016).

In addition to higher rates of beach erosion and substrate coarsening by increased wave energy, bulkheads would also prevent input of sediment from landward of the bulkhead to the beach, further diminishing the supply of fine sediment. Finer material like gravel and sand provide important spawning substrate for sand lance and surf smelt. Therefore, a reduction to this substrate type within the intertidal and nearshore zone as a result of the bulkhead would reduce potential spawning habitat availability and fecundity of both species (Rice 2006; Parks et al. 2013), which are both important prey species for salmonids. As a result of deepening of the intertidal zone adjacent to the bulkhead, as well as increased wave energy, the repaired, replaced, or new bulkhead would also be expected to reduce SAV (Patrick et al. 2014). This would be expected to cause a reduction in potential spawning habitat (i.e., eelgrass) for Pacific herring, another forage species for salmonids. Another benefit of forage fish abundance to salmonids is their use as a prey buffer for predation by marine mammals and piscivorous birds. Moore et al. (2021) found that the high abundance of age-1+ anchovy in the Puget Sound provided an alternative prey source for predators of outmigrating steelhead smolts which resulted in an increase in smolt survival.

Along with physical loss of habitat, the impacts of nearshore modification include the loss of functions such as filtration of pollutants, floodwater absorption, shading, sediment sources, and nutrient inputs. The greatest impacts to the nearshore are from shoreline armoring; but roads and artificial fill are also significant, and these stressors often occur together or with other modifications (Fresh et al. 2011). Shoreline armoring generally reduces the sediment available for transport by disconnecting the sediment source, e.g. a feeder bluff, from the drift cell, potentially causing loss of beach width and height as transport of material outpaces supply. This can occur at the site of the structure or down the drift cell. Structures in the intertidal zone change the hydrodynamics of the waves washing up on the beach. Hard structures reflect waves without dissipating their energy the way a natural beach would, especially if vegetation is present. This energy can lower the beach, make it steeper, and wash away fine sediments. Dikes and fill reduce estuarine wetlands and other habitat for salmon, forage fish, and eelgrass.

When the physical processes are altered, there is also a shift in the biological communities. The number and types of invertebrates, including shellfish, can change; forage fish lose spawning areas; and juvenile salmon and forage fish lose the feeding grounds that they use as they migrate along the shore (Shipman et al. 2010). Native shellfish and eelgrass have specific substrate requirements and altered geomorphic processes can leave shellfish beds and eelgrass meadows with material that is too coarse or with too much clay exposed. Shoreline armoring can also physically bury forage fish spawning beaches when structures are placed in or too close to the intertidal zone. When shoreline development removes vegetation, the loss of shading and organic material inputs can increase forage fish egg mortality (Penttila 2007). Surf smelt, for example, use about 10 percent of Puget Sound shorelines for spawning and many bulkheads are built in forage fish spawning habitat, threatening their reproductive capacity (Penttila 2007). The effects of nearshore modification cascade through the Salish Sea food web. The consequences can be seen in the population declines of a variety of species that depend on these ecosystems, from shellfish, herring, and salmon to orcas, great blue heron, and eelgrass.

Armoring of the nearshore can reduce or eliminate shallow water habitats via two distinct mechanisms. First, bulkheads cause a higher rate of beach erosion waterward of the armoring because there is higher wave energy, compared to a natural shoreline. This leads to beach lowering, coarsening of substrates, increases in sediment temperature, leading to reductions in primary productivity and invertebrate density within the intertidal and nearshore environment (Bilkovic and Roggero 2008; Fresh et al. 2011; Morley et al. 2012; Dethier et al. 2016). As a result of deepening of the intertidal zone adjacent to the bulkhead, as well as increased wave energy, bulkheads also reduce SAV (Patrick et al. 2014). We expect reduced SAV to cause a reduction in potential spawning habitat (i.e., eelgrass) for Pacific herring, another forage species of Chinook salmon and juvenile PS/GB bocaccio. Reduced SAV also diminishes habitat for larval rockfish, which in their pelagic stage rely on SAV for prey and cover for several months. Second, bulkheads located within the intertidal zone (below HAT) prevent upper intertidal zone and natural upper intertidal shoreline processes such as accumulation of beach wrack (Sobocinski et al. 2010; Dethier et al 2016). This is an additional mechanism that reduces primary productivity within the intertidal zone and diminishes invertebrate populations associated with beach wrack (Sobocinski et al. 2010; Morley et al. 2012; Dethier et al. 2016). Reductions in forage from bulkheads then affect primary productivity and invertebrate abundance in both the intertidal and nearshore environments. Invertebrates are an important food source for juvenile PS/GB bocaccio and PS Chinook salmon and for forage fish prey species of salmonids.

In addition to loss of shallow areas through higher rates of beach erosion and substrate coarsening by increased wave energy, bulkheads also prevent the input of sediment from sources landward of the bulkhead to the beach, further diminishing the supply of fine sediment. Finer materials like gravel and sand provide important spawning substrate for sand lance and surf smelt. Therefore, a reduction to this substrate type within the intertidal and nearshore zone as a result of the bulkhead would reduce potential spawning habitat availability and fecundity of both species (Rice 2006; Parks et al. 2013), which are both important prey species of PS Chinook salmon, and juvenile PS/GB bocaccio, both of which depend on nearshore areas for forage. Thus, the loss of material below bulkheads, together with the loss of upland sources of material from above the bulkheads, over time, can affect the migration and growth of juvenile salmonids (primarily PS Chinook salmon) by reducing the amount of available shallow habitat that juveniles rely on for food and cover, and by preventing access to habitat upland of bulkheads at high tides. Both salmonids and juvenile bocaccio are affected by the loss of prey communities. Larval rockfish of both species—PS/GB bocaccio and PS/GB yelloweye—are affected by the loss of SAV.

SSNP includes the repair, replacement, and construction of new shoreline modifying structures such as marine bulkheads. Since these structures are designed to stabilize or “armor” the shoreline, it is challenging to incorporate design features that limit the impacts of these structures. In other words, design features that limit the impacts of bulkheads also reduce their effectiveness. SSNP primarily relies on conservation offsets to compensate for the impacts of structures that modify or armor shorelines of the Salish Sea. By requiring these offsets, SSNP achieves a no-net loss approach to maintaining habitat forming process and nearshore habitat quality.

Treated wood.
Inorganic arsenical pressure-treated wood piles (chromated copper arsenate (CCA) or ammoniacal copper zinc arsenate (ACZA) that are sealed with a wrapping or a polyurea barrier may be installed under this programmatic action. Treated wood may also be used for the construction, repair, replacement, or maintenance of substructures on bridges, boardwalks, docks, footbridges, piers, and stringers. If the Corps or a permittee would like to use treated wood for other purposes, then individual consultation would be required.

A pesticide-treated wood structure placed in or over flowing water will leach copper and a variety of other toxic compounds directly into the stream (Hingston et al. 2001; Kelly and Bliven 2003; Poston 2001; Weis and Weis 1996). Although the likelihood of leaching pesticides, including copper, from wood used above or over the water is different than splash zone or in-water applications (Western Wood Preservers Institute et al. 2011), these accumulated materials add to the background loads of receiving streams. Movement of leached preservative components is generally limited in soil but is greater in soils with high permeability and low organic content. Mass flow with a water front is probably most responsible for moving metals appreciable distances in soil, especially in permeable, porous soils. Preservatives leached into water are more likely to migrate downstream compared with preservatives leached into soil, with much of the mobility occurring in the form of suspended sediment. If shavings, sawdust, or smaller particles of pesticide-treated wood generated during construction, use, or maintenance of a structure are allowed to enter soil or water below, they make a disproportionately large contribution to environmental contamination because the rate of leaching from smaller particles is 30 to 100 times greater than from solid wood (FPL 2001; Lebow 2004; Lebow and Tippie 2001).

Copper and other toxic chemicals, such as zinc, arsenic, chromium, and PAHs, that leach from pesticide-treated wood are likely to adversely affect salmon andsteelhead, that spawn, rear, or migrate by those structures, and when they ingest contaminated prey (Poston 2001). Early efforts by NMFS to analyze the science applicable to treated wood impacts on anadromous fish (NMFS 1998, cited in NOAA Fisheries 2009) assumed that certain thresholds for exposure were protective of fish, including juvenile salmon, for example a water column concentration of 7 ppb for copper as a threshold for behavioral avoidance by salmon and 0.018 toxic units for PAH as adequately protective against toxic effects or bioaccumulation. NMFS relied on the 1998 document when developing the 2004 SLOPES biological opinion (NMFS 2004).

More recent studies have shown that copper impairs the olfactory nervous system and olfactory-mediated behaviors in salmon and steelhead at levels as low as 2.0 pbb (Sandahl et al. 2007; Baldwin et al. 2003; Baldwin and Scholz 2005; Linbo et al. 2006; McIntyre et al. 2008; Feist et al. 2011, Scholz et al. 2011, Spromberg and Scholz 2011).

Moreover, we now have more sophisticated understandings of the synergistic impacts of copper and PAH when combined with other contaminant and stressors, as well as a greater appreciation for the repeated exposures of anadromous fish during the life cycle. Specifically, all life history stages of salmon are typically exposed to complex environmental mixtures of other toxic compounds (e.g., other metals, pesticides, weathered PAHs) in conjunction with other stressors (e.g., elevated temperatures, low dissolved oxygen) through a variety of exposure routes other than the water column, including consumption of contaminated prey items (dietary) or direct contact with contaminated sediments (Sandahl et al. 2007, Macneale et al. 2010, Scholz et al. 2011, Feist et al. 2011, Laetz et al. 2014). No stand-alone thresholds take into account these multiple routes of exposure or the potential impacts of complex mixtures of contaminants on olfaction or other physiological functions. Interactions among multiple stressors, including contaminant mixtures, were far beyond the scope of the NMFS 1998 guidelines, or any other current guidelines, and warrant careful consideration in site-specific assessments.

The proposed action significantly limits exposure of fish to the adverse effects of treated wood by minimizing the use of treated wood to only be used to maintain or repair over water substructures that are not in direct exposure to leaching by precipitation, overtopping waves, or submersion. Any chemicals that enter the water column will likely be very small due to the minute amount of treated wood that is in indirect contact with the aquatic environment, unexposed to precipitation, and at low risk of abrasion. In addition, for overwater structure maintenance and repair, treated wood is subject to strict conditions. Those limits include requirements that any treated wood will first be inspected to ensure that no visible residue, bleeding of preservative, preservative-saturated sawdust, contaminated soil, or other matter is present, then stored out of contact with standing water and wet soil and protected from precipitation. The use of prefabrication is required whenever possible to ensure that cutting, drilling and field preservative treatments are minimized. When field fabrication is necessary, all cutting and drilling of pesticide-treated wood, and field preservative treatment of wood exposed by cutting and drilling, will occur above OHW (riverine) or above the HAT (marine) to minimize discharge of sawdust, drill shavings, excess preservative and other debris in riparian or aquatic habitats. Tarps, plastic tubs or similar devices will be used to contain the bulk of any fabrication debris, and any excess field preservative will be wiped off.

Additionally, any project that requires removal of pesticide-treated wood will ensure that, to the extent possible, no wood debris falls into the water. If wood debris does fall into the water, it will be removed immediately. After treated wood is removed, it will be placed in an appropriate dry storage site until it can be removed from the project area. When these measures are considered collectively, they will significantly limit the amount of toxic preservatives reaching water bodies occupied by ESA-listed fish.

Because of these limitations and conditions, the actual area where we expect juvenile fish to experience sublethal effects, such as reduced foraging success and reduced growth, is so small relative to the total area occupied by juvenile fish, and the total area of designated critical habitat, we do not expect the impacts of treated wood use to alter population growth rate, abundance, or any other demographic characteristic.

Alternatives to treated wood that are used could also have some adverse effects. Materials such as wood that is not treated with pesticides (e.g., redwood, cedar, cypress, or exotic hardwoods) or less toxic preservatives (e.g., sodium silicate), galvanized steel, concrete, recycled plastic lumber, rubber, or composite materials are increasingly being used in aquatic construction projects due to expected longevity, increased strength, and minimal leaching characteristics (USEPA 2014, Hutton and Samis 2000, Stratus 2006a). Those materials are all likely to contain little, if any, copper or PAH, but may include other metal or synthetic materials that cannot be considered entirely non-toxic (USEPA 2014, Hutton and Samis 2000, Stratus 2006a).

SSNP PDC allows for the use of treated wood piles with pile wraps and polyurea coatings. Pile wraps and polyurea coating are described as barrier protection systems adhered or otherwise permanently affixed to the treated wood that includes boots, sleeves, wraps, and spray on coatings that meet minimum thickness standards (American Wood Protection Association 2016). Pile wraps and polyurea coatings are effective at minimizing the rate of leaching from pressure-treated wood piles and are widely used (Brown 2011; Khan et al. 2004; Konkler and Morrell 2017; NMFS 2009a; Pendleton 1990; Poston 2001; Schottle and Prickett 2010; Stratus 2006a). A 2010 study concluded that the use of four different pile wraps were effective in minimizing short-term (≤ 1 month) metal leaching rates from ACZA pressure-treated pilings (ranging from 0.12±.02 to 61.1±9.4 mg/cm²/day) compared to unwrapped treated piles that did not exceed .01µg/cm²/day (Schottle and Prickett 2010). The Naval Civil Engineering Laboratory participated in two long-term studies determining the effectiveness of plastic barrier systems for treated wood piles (Pendleton 1990). They concluded that there was no visible marine borer damage, no polyurethane adhesion loss, and the wraps remained intact after five years of marine aquatic exposure (Pendleton 1990). Wraps can be prefabricated using outer plastic wraps such as PVC, HDPE, or fiber-glass reinforced (RFP) plastic products with an epoxy fill, petrolatum saturated tape (PST) or an inner wrap of polyethylene in the void between the wrapping and pile to seal the preservative treated wood pile.

If the pile wrap becomes damaged, there is potential for a breach to occur, however unlikely, in-between the pile and the wrapping which would result in a sudden release of contaminants into the immediate environment (Schottle and Prickett 2010; Stratus 2006a; 2006b). If a breach occurs, metals will leach at a higher rate than an unwrapped treated pile. However, the contaminants are expected to be localized and proportional to the area of the exposed wood, and anticipated to reduce to “minute levels” within a short time period (days to weeks) (Poston 2001). Pile wraps can also result in a sudden release of contaminants due to failed points along seams and fasteners from wood expansion and contraction over time (Brown 2011). After being in-water for one month, Schottle and Prickett (2010) intentionally cut a small square from both the inner and outer wraps to determine the rate of leaching from ACZA-treated wood. Significant leaching occurred from the breach, especially a high short-increase in copper. Any failure points that are likely to occur is likely to be small and proximal to the area and will likely decrease over time. By installing wraps prior to installation and following an inspection and maintenance program that is reviewed and verified by NMFS, the likelihood of a breach occurring is minimal and we do not expect adverse effects to occur. Inspections will occur every 1-2 years beginning 3-5 years after installation and repairs will be made if damage has occurred to 25 percent or more to the barrier surface on an individual pile. Repairs consist of adding additional coating or barrier material to mitigate for any future preservative loss.

Polyurea coatings have been used in numerous projects and are currently required in some California ports (Konkler and Morrell 2017). Seamed and sealed coatings are effective as long as they are “an impact-resistant, biologically inert coating that lasts or is maintained” (NMFS 2009a). Konkler and Morrell (2017) found metal levels within the water column, containing coated ACZA-treated wood, were below detection limits (0.05 mg/kg for each element) and remained low (<4 mg/kg of metal concentration) within the sediment in a synthetic salt water, non-circulating environment.

NMFS expects the use of pile wraps and polyurea coating to minimize the rate of leaching from pressure-treated wood piles and an inspection and maintenance program will reduce the likelihood of a breach occurring and no more than minimal leaching of preservatives occur from the use of wrapped piles.

2.5.5 Effects of the Proposed Activity Categories

Culvert and bridge repair and replacement resulting in improvements for fish passage.
The effects of these projects include the temporary construction effects described above. This includes actions necessary to complete geotechnical surveys, such as access road construction, drill pad preparation, mobilization and set up, drilling and sampling operations, demobilization, boring abandonment, and access road and drill pad reclamation. Excavation, grading, and filling necessary to maintain, rehabilitate, or replace existing roads, culverts, and bridges, and to construct and maintain stormwater facilities are also included. Below, we analyze the effects of stormwater runoff from roadways.

Stormwater runoff from the highway system, including roads, culverts, and bridges, delivers a wide variety of pollutants to aquatic ecosystems, such as nutrients, metals, petroleum-related compounds, sediment washed off the road surface, and agricultural chemicals used in highway maintenance (Buckler and Granato 1999; Colman et al. 2001; Driscoll et al. 1990; Kayhanian et al. 2003). These ubiquitous pollutants are a source of potent adverse effects to salmon and steelhead, even at ambient levels Johnson et al. 2007; Loge et al. 2006; Sandahl et al. 2007; Spromberg and Meador 2006), and are among the identified threats to sturgeon. Feist et al. (2017) surveyed and modeled distinct coho salmon spawning reaches across a gradient of urbanization in the Puget Sound basin and found that contaminants in stormwater runoff from the regional transportation grid likely cause coho salmon mortality. Furthermore, Feist et al. (2017) concluded that coho salmon in more urbanized watersheds are vulnerable to non-point source pollution regardless of the timing, intensity, and frequency of storms. The proposed design criterion for stormwater management will treat stormwater flows associated with more than 95 percent of the annual average rainfall. Runoff from impervious surfaces within each project area being treated at or near the point at which rainfall occurs using low impact development, bioretention, filter subsoils, and other practices that have been identified as excellent treatments to reduce or eliminate contaminants for highway runoff (Barrett et al. 1993; Center for Watershed Protection and Maryland Department of the Environment 2000 (revised 2009); Feist et. al. 2017; Herrera Environmental Consultants 2005; Hirschman et al. 2008; National Cooperative Highway Research Program 2006).

The proposed stormwater treatment practices, such as bioretention, bioslopes, infiltration ponds, and porous pavement, supplemented with appropriate soil amendments as needed, are excellent treatments to reduce or eliminate contaminants from runoff (Barrett et al. 1993; Center for Watershed Protection and Maryland Department of the Environment 2000 (revised 2009); Hirschman et al. 2008; National Cooperative Highway Research Program 2006; Washington State Department of Ecology 2004; Washington State Department of Ecology 2014). Stormwater treatment may also include source control BMPs, which prevent pollution, or other adverse effects of stormwater, from occurring. Source control BMPs include methods as various as using mulches and covers on disturbed soil, putting roofs over outside storage areas, and berming areas to prevent stormwater run-on and pollutant runoff.

Flow control BMPs typically control the volume rate, frequency, and flow duration of stormwater surface runoff. The need to provide flow control BMPs depends on whether a development site discharges to a stream system or wetland, either directly or indirectly. Stream channel erosion control can be accomplished by BMPs that detain runoff flows and also by those which physically stabilize eroding streambanks. Both types of measures may be necessary in urban watersheds. Construction of a detention pond is the most common means of meeting flow control requirements. Construction of an infiltration facility is the preferred option but is feasible only where more porous soils are available.

Although SNPP requires that actions will capture, manage, and treat runoff up to the design storm level from most proposed projects causing effects from stormwater, treatment will not eliminate and may not even significantly reduce all pollutants in the runoff currently produced at project sites. Thus, adverse effects of non-point source pollution will persist for the design life of projects covered under SSNP.

Utilities

Utility work, whether new services[58] or repair or replacement of existing infrastructure, typically occurs as either underground or aboveground infrastructure. Both underground and aboveground utilities can include pipes or pipelines used to transport gas or liquids; cables, lines, or wires used to transmit electricity or communications; and attendant infrastructure such as buried or aboveground vaults, access ports, pump stations/substations, poles, transmission towers, buildings, and foundation footings. New installation, repair, or replacement of utility lines requires road access, staging and laydown areas, and removal of riparian and upland vegetation. Much of the potential effects associated with these activities are covered under the discussion of temporary construction effects. Utility projects will incorporate the relevant PDC regarding project design and construction practices.

Where utility work differs from general construction activities depends on whether it is underground or overhead infrastructure. Belowground utilities may cross aquatic resources (streams, rivers, wetlands, estuaries, nearshore marine areas) through open trenching across the resource, boring/directional drilling/tunneling[59] under the resource, and laid submerged on the sediment surface.

Trenching across tidally influenced streams directly affects habitat that may be used by listed species and may directly affect listed species if conducted when such species are present. Open trenching must be isolated from the aquatic environment, unless conducted when an ephemeral

[58] Utilities supporting new service areas are not covered under this programmatic action because the indirect effects of such actions—primarily increased growth and development—cannot be assessed programmatically in any meaningful manner.
[59] Boring, drilling, and tunneling are differing techniques for passing a utility line under an aquatic resource. This document will use the terms interchangeably, as each method tends to have similar potential effects on species and habitat resources.

stream is dry. If conducted in the dry, measures must be instituted to prevent fugitive sediment migration when stream flows return. All trenched areas must be deep enough to prevent utility infrastructure exposure and must maintain pre-disturbance fluvial and geomorphic processes. Finally, trenched crossings must restore the streambed to its pre-disturbance contours utilizing native materials of the size and distribution of the surrounding conditions.

Boring, directional drilling, or tunneling under aquatic resources avoids many of the impacts associated with stream crossings. However, such methods can result in a frac out, where drilling fluids can fracture through the soils, breaching into the aquatic resource. A frac out contingency plan is required for all drilling operations, including having necessary equipment on-site to clean up drilling fluids that reach the aquatic environment. A frac out results in the short-term direct effects to listed species, if present, and long-term impacts to habitat quality, depending on scale of frac out, toxicity of drilling fluids, and effectiveness of clean up response. Implementation of these requirements and the appropriate PDCs, listed above, will still result in a temporary riparian and streambank disturbance, spills or leaks of fuel, lubricants, hydraulic fluid, coolants, and other contaminants, and temporary fish displacement.

Submerged utilities lay on the sediment surface, typically relying on their own weight to keep them in place. Installation of submerged utilities typically result in short-term, construction-related, direct effects to listed species, if present, and a small loss of habitat available under the footprint of the utility.

Aboveground utilities cross aquatic resources attached to bridges or other overwater structures, and suspended from poles or towers. Bridge crossings typically include attaching utilities to an existing bridge, or constructing an elevated crossing of the utility line (typically a pipe) over the aquatic resource. When attaching a utility to an existing crossing structure, many of the likely impacts are temporary disturbance effects (e.g., barge use, construction noise, heavy equipment, erosion control). Overhead crossings typically include attaching utility lines to poles or towers so that they can span over water. Such aboveground utilities often require an easement that must be kept clear of vegetation for access to all, or a potion, of the utility's length.

In summary, effects from utility projects are primarily short-term and caused by construction. Footings and foundations for poles or towers can permanently displace aquatic or terrestrial vegetation and habitat. Conservation offsets are required when footings and foundations result in an enduring loss of nearshore habitat quality.

<u>Stormwater facilities and outfalls</u>
Most direct and indirect effects of stormwater facility actions are similar to the effects of temporary construction effects discussed above, and will follow the general construction measures as applicable.

Treatment of post-construction stormwater as proposed as part of the SSNP proposed action runoff reduces the amount of these contaminants entering the freshwater and estuary habitats of listed species. The treatment protocols required by SSNP is based on a design storm (50 percent of the 2-year, 24-hour storm) that will generally result in more than 95 percent of the runoff from all impervious surfaces within the action area being infiltrated at or near the point at which rainfall occurs. Stormwater infiltration treatment practices, such as such as bioretention, bioslopes, infiltration ponds, and porous pavement, supplemented with appropriate soil amendments as needed are highly effective treatments to reduce or eliminate contaminants from runoff (Barrett et al. 1993; Center for Watershed Protection and Maryland Department of the Environment 2000 (revised 2009); Hirschman et al. 2008; National Cooperative Highway Research Program 2006; Spromberg, et al. 2016; Washington State Department of Ecology 2004; Washington State Department of Ecology 2014).

As describe earlier, no current stormwater treatment practice is 100 percent effective in removing all contaminants. Even with the proposed treatment required under SSNP, stormwater discharged to nearshore area, estuaries, or tidal-influenced streams will contain contaminants including PAHs, fertilizers, pesticides, metals, and 6PPD-quinone. The contaminants degrade water quality and have a wide range of adverse effects on the listed species addressed by this opinion. However, the requirement to treat stormwater to the specification of PDC #13 is expected to minimize the stormwater impacts caused by the proposed action

<u>Shoreline Modifications.</u>
The effects of projects authorized under this activity category include temporary construction as well as enduring effects caused by the marine bulkheads. These impacts are described in the previous sections of this opinion. Conservation offsets are required to compensate for enduring loss of nearshore habitat quality. Shore modification projects designed using hybrid methods will have similar adverse on habitat forming processes, but the magnitude of the impact is considerably less than the impact caused by projects using rock, sheet pile, or concrete bulkheads. Projects using soft shoreline treatments will have minimal effects on nearshore habitat forming processes.

<u>Expand or install a new in-water or overwater structure</u>
The construction of new of the expansion of existing in-water or overwater structures will cause temporary construction effects as discussed earlier in this opinion. The use and maintenance of overwater structures will cause intermittent effects such as impacts caused by vessel operation. Overwater structures also cause enduring effects on nearshore habitat. Intermittent and enduring effects, as well as the conservation offsets required for this activity category, are thoroughly discussed earlier in this opinion.

<u>Repair or replace an existing structure.</u>
Repair or replacement of existing overwater and in-water structures will cause temporary construction effects as discussed earlier in this opinion. The types of repair or replacement projects covered under the SSNP proposed action will prolong the life of the subject structures, and as such, future effects caused by those structures are considered effects of the proposed action. The use and maintenance of overwater structures will cause intermittent effects such as impacts caused by vessel operation as discussed above. Overwater structures also cause enduring effects on nearshore habitat. Intermittent and enduring effects are thoroughly discussed earlier in this opinion.

Minor Maintenance of an Existing Structure.
We expect this activity category result in the short-term construction impacts described above. The types of actions proposed for this category do not meaningfully prolong the life of structures and thus the impacts from the structures themselves are not considered effects of the action.

Repair, replace, expand or install a new aid to navigation, scientific measurement device, or tideland marker
Installation of aids to navigation, scientific measurement devices, or tideland markers will cause some minor construction effects. Some of these structures may require the pile driving. The structures themselves are too small to have any meaningful impact on marine habitat.

Dredging for vessel access.
To predict the likely level of activity and impact resulting from dredging to be authorized under SSNP, we consider the recent level of activity (total annual volume of dredged material).

Dredging will occur to remove sediments necessary to maintain access to existing docks, marinas, port terminals, industrial docks and wharfs, and water diversions. Dredging and disposal of the dredged material speed up the natural processes of sediment erosion, transportation, and deposition (Morton 1977). Dredging and disposal temporarily increases turbidity, changes bottom topography with resultant changes in water circulation, and changes the properties of the sediment at the dredge and disposal sites (Morton 1977). The effects of turbidity on listed are discussed below. These effects are significant in proportion to the ratio of the size of the dredged area to the size of the bottom area and water volume (Morton 1977).

Many areas within the action area have contaminated sediments. The proposed PDC require adequate testing of sediments prior to dredging to limit resuspension of toxic materials. The Corps and resource agencies have developed a methodology to analyze sediments for toxicity and suitability for in-water disposal.

Extraction of bed material in streams with upland disposal causes bed degradation (NMFS 2005b). Gravel extraction sites trap incoming bedload sediment, passing ‘hungry water’ downstream, which typically erodes the channel bed and banks to regain at least part of its sediment load (Kondolf 1997). Gravel removal may cause downstream erosion if the area subsequently receives less bed material from upstream than is being carried away by fluvial transport. Thus, gravel removal not only impacts the extraction site, but also reduces gravel delivery to downstream areas. In some areas, there are sufficient amounts of material being delivered that upland disposal is not problematic. The requirement to dispose of the material within the stream/river will prevent this from happening. Upland disposal from dredging in the estuary has minimal effects on channel process due to the estuarine sediment transport processes and the small ratio of anticipated volumes of dredge sediment to basin sediment delivery. Under the proposed action, the locations where dredging will occur is limited to one-time dredge events and the total scale of dredging impacts will likely be small. No large-scale dredging or channel maintenance is proposed. Under SSNP, we expect most of the dredging to occur in marine areas, so some of the effects on streams, as described above, are likely to occur very infrequently.

For a fish to avoid entrainment into the draghead it must first detect and react to the ship, cutterhead, or pipeline, and then the fish must react quickly to avoid exposure to the zone of influence around the cutterhead or pipeline. Smolt and juvenile listed fish will be passing through the riverine/estuarine portions of the individual project areas on route to the ocean, and therefore are at an increased risk of exposure due to the presence of the cutterhead or pipeline in the migratory corridor. Noise and vibration from the dredge vessel and cutterhead or pipeline during operation may discourage most fish from getting close and thereby avoid encountering the zone of influence.

When juvenile salmonids come within the zone of influence of the cutter head, they may be drawn into the suction pipe (Dutta 1976; Dutta and Sookachoff 1975a). Dutta (1976) reported that salmon fry were entrained by hydraulic pipeline dredging in the Fraser River. During studies by Braun (1974a, 1974b) almost 99 percent of entrained juveniles were killed. Hydraulic pipeline dredging operations caused a partial destruction of the anadromous salmon fishery resource of the Fraser River (Dutta and Sookachoff 1975b). Hydraulic pipeline dredges operating in the Fraser River during fry migration took substantial numbers of juveniles (Boyd 1975). Further testing in 1980 by Arseneault (1981) found entrainment of chum and pink salmon but in low numbers relative to the total of salmonids outmigrating (0.0001 to 0.0099 percent).

The Corps conducted extensive sampling during hydraulic dredging within the Columbia River in 1985-88 (Larson and Moehl 1990) and again in 1997 and 1998 in Oregon coastal bays and estuaries. In the 1985-88 study no juvenile salmon were entrained. In the 1997-98 study two juvenile salmon were entrained. Examination of fish entrainment rates in Grays Harbor from 1978 to 1989 detected only one juvenile salmon entrained (McGraw and Armstrong 1990). Dredging was conducted outside peak migration times. No evidence of fish mortality was found while monitoring dredging activities along the Atlantic Intracoastal Waterway. These conflicting Fraser and Columbia River studies examined deep-water areas associated with main channels. There is little information on the extent of entrainment in shallow-water areas, such as those associated with the proposed action.

In the absence of definitive information, the NMFS makes the biologically conservative assumption that hydraulic and/or pipeline dredging in shallow-water areas of existing docks, marinas, port terminals, industrial docks and wharfs, and water diversions are likely to entrain some juvenile salmon or rockfish if they are present during operations. The timeframe for dredging operations varies by project, but some will occur when listed fish are present.

Estimating the number of individual fish injured or killed from entrainment during dredging is difficult because the number of fish passing through each of the individual project action areas will vary from day-to-day and the number of individuals moving into the site between dredging events is unknown. Further, dredging primarily occurs outside of peak migration periods for ESA listed aquatic species. Dredging does not typically occur over the entire navigational channel footprint and dredging events proposed under this programmatic opinion are a result of natural disaster declared events and will focus on maintenance of existing structures (docks, marines, water intakes) in order to maintain vessel access and functionality to these structures. Furthermore, while individuals may be present at the initial start-up of operations, it is reasonably certain that during operations, individual fish could easily move out of the area to avoid the discharge plume. Based on these, the number of ESA listed aquatic species to be exposed to dredging operations at each project site is likely low. Furthermore, PDC #9 includes multiple design criteria to minimize impacts on fish.

Disposal quantities and discharge time are important variables to consider while assessing the likelihood for juvenile ESA listed aquatic species to be adversely affected through a physical injury from disposed material. The amount and weight of dredged material is significant for a small fish in order to resist from being entrained by the descending material and dragged down to the river/estuarine floor. The quantity of dredge material displaces a large volume of water; therefore, if some fish are pushed ahead of the discharge plume they would be entrained within the vortices of the turbulent flow. Accurately determining the number of individual ESA listed aquatic species is difficult because there is no accurate or precise way to count the number of individuals exposed in the area or volume of water adversely affected by disposal with each disposal event. Thus, the most appropriate indicator that describes the quantitative magnitude of physical injury from disposed material is the amounts of materials dredged at each project dredging location.

Dredging authorized under SSNP is restricted to existing dredge prisms. As a result, the impacts identified above are limited to previously dredged areas. This analysis also assumes a maximum of approximately 34,000 cubic yards of material to be dredged each year. Conservation offsets are required to compensate for the enduing loss of nearshore habitat caused by dredging.

Dredging and debris removal to maintain functionality of culverts, water intakes, or outfalls. The effects of this activity category are identical to the effects described for dredging for vessel access, above, except for the magnitude of the impact. Dredging actions to maintain functionality of culverts, water intakes, and outfalls are typically much smaller than vessel access dredging actions. In many cases, the amount of material removed for functionality dredging is ten times less than for a typical vessel access project. For the purpose of our analysis, we assume the maximum amount of material dredged annually for this activity category is 500 cubic yards,

Habitat Enhancement Activities

This activity includes wetland, shoreline, tidal stream, and floodplain restoration. Restoration actions could be standalone projects or an action taken to achieve conservation offsets. Restoration and enhancement of natural habitat qualities, functions, and processes are the primary purposes of these activities. In most cases, heavy equipment will be used to remove and/or regrade fill. However, stream and wetland restoration activities will all use bioengineering techniques. For streambank restoration, this includes bank reshaping, installing pieces of large wood, and planting native vegetation to increase soil strength, bank integrity, and provide resistance to erosion in an ecological approach (Mitsch 1996; WDFW et al. 2003). Bioengineering solutions use natural materials to increase erosion resistance and bank roughness to disrupt stream energy while reestablishing natural habitat functions and processes. For wetland restoration, this includes removal of non-native fill, recontouring elevations, decompacting soils, and planting native vegetation.

Reestablishment of native riparian forests or other appropriate native riparian plant communities, provide increased cover, increased habitat complexity, and a long-term source of all sizes of instream wood. They also reduce fine sediment supply, increase shade, moderate microclimate effects, and provide more normative channel migration over time. Most long-term effects from streambank restoration on listed fish and their habitat are expected to be positive, but in some limited circumstances, a project could slow natural channel migration, resulting in a small loss of channel complexity over time.

The long-term effects of wetland restoration are wholly beneficial. Some of the benefits are restoring more natural floodplain and flood flow conditions, improving aquatic organism passage, and increasing soil infiltration, ground water recharge, sediment filtering, and nutrient absorption from runoff.

Restoration of floodplain habitat includes removal of fill material to reconnect existing stream channels to historical off- channel habitat and side-channels. Side channel wetlands and ponds provide important benefits such as high value as summer and winter rearing habitat for salmon (Cramer 2012).

This activity category also includes the removal of derelict fishing gear, untreated and chemically treated wood pilings, piers, and boat docks as well as similar structures comprised of plastic, concrete, and other material. Construction and water quality impacts of removing piles were also analyzed in our assessment of construction impacts earlier in this document.

Piling and other structure removal from waterways will improve water quality by eliminating chronic sources of toxic contamination and associated impacts to nearshore dependent species. Removal will also restore impacted substrates because the presence of the structure prevents recovery of important freshwater, intertidal, and subtidal habitats. Removals will occur in estuaries, lakes, rivers, and oceans because items to be removed are typically used in association with boat docks and other water-dependent facilities.

During pile or other debris removal, sediments will be re-suspended because they are inevitably pulled up with, or attached to, the piles, fishing gear, vessels or other items. If sediment in the vicinity of the removed item is contaminated, or if the pile is creosote treated, those contaminants will be included with the re-suspended sediments, especially if a creosote-treated pile is damaged during removal. Due to the relatively small amount of sediment disturbed during pile removal, re-suspended sediment will be localized and temporary. For larger items like derelict vessels, the SSNP GCM #10 requires use of a containment boom and floating silt curtain around the vessel to contain any debris and turbidity. Vessels will be also lifted with a crane barge or lift bags to minimize the overall extent of sediment disturbance. Prior to removal, the vessel will also be investigated for any petroleum products or other hazardous materials and these substances will be removed. The long-term effects of structure removal will be beneficial, including substrate recovery and reduction of resting areas for piscivorous birds, hiding habitat for aquatic predators, and, in the case of preservative-treated piles, a chronic source of contamination.

Habitat enhancement often involves construction activities that typically cause some short-term adverse effects. These effects were described in detail in Section 2.5.2.

Set-back or removal of existing tidegates, berms, dikes, or levees.
Activities covered under this category could be standalone projects or an action taken to achieve conservation offsets. Channelization of estuaries and tidal streams through berm, dike, and levee construction eliminates the floodplain benefits during floods, producing many of the same changes to living communities and ecosystems as those resulting from dams. Berms, dikes, tidegates, and levees are commonly found along mid-to large-sized rivers or estuaries for flood control or infrastructure protection and can severely disrupt ecosystem function (Gergel et al. 2002) and fish community structure (Freyer and Healey 2003).

The effects of setting back or removing existing bulkheads, berms, dikes, tidegates and levees are similar to off-channel, side-channel, and floodplain habitat restoration discussed above, although the effects of this type of action may also include short-term or chronic instability of affected streams and rivers as channels adjust to the new hydrologic conditions. Moreover, this type of action is likely to affect larger areas overall because the area isolated by a berm, dike or levee is likely to be larger than that included in an off- or side-channel feature. For constructability, many activities will be timed with low tidal cycles which also minimizes short-term effects including sediment generation. Because of their locations and elevations, work area isolation is not needed for most berm, dike, and levee projects. Thus, they do not result in fish capture and handling. Some tidegate removals may require work area isolation and fish relocation.

Salmonids and other fishes benefit from restoring the processes that maintain floodplain complexity (Bellmore et al. 2013). Set-back or removal of existing bulkheads, berms, dikes, tidegates and levees increases habitat diversity and complexity, restores shoreline habitat forming processes, moderates flow disturbances, and provides refuge for fish during high flows. Floodplain heterogeneity is associated with the occurrence of a mosaic of food webs, all of which are utilized by anadromous salmonids and other estuarine fishes, and all of which may be important to their recovery and persistence. Other restored ecological functions include overland flow during flood events, dissipation of flood energy, increased water storage to augment low flows, sediment and debris deposition, growth of riparian vegetation, nutrient cycling, and development of side channels and alcoves. Set-back or removal of bulkheads, berms, dikes, and levees will result in a long-term increase in nearshore or floodplain function. The scale of that improvement will depend on the size of the proposed action. Most importantly, other than short-term adverse construction impacts, effects of these activities are expected to be positive on ecosystem function.

Set-back or removal of existing tidegates, berms, dikes, or levees involves construction activities that typically cause some short-term adverse effects. These effects were described in detail in Section 2.5.2.

Beach nourishment.
Beach nourishment is an activity designed to provide an ecological uplift through the rehabilitation or restoration of beach substrate through placement of suitable substrate materials. Activities covered under this category could be standalone projects or an action taken to achieve conservation offsets. Placement of substrate material will occur in the high tide zone of the beach or shore. Some short-term suspended events are likely as the materials are naturally redistributed

by wave, wind, current, or tidal action. Suitable materials will not be contaminated with toxics or hazardous materials. Existing substrate will be disturbed during materials placement, but redistribution will restore organisms and natural processes in a zone that routinely experiences disturbance in normal tide cycles or seasonal fluctuations in river flows. Placed materials will also closely match the existing substrates. Beach nourishment activities address sediment deficits and allow for wave energy dissipation, which contribute to improved ecological processes. In many areas beach nourishment will provide improved nursery grounds and other habitat for forage fish species. Improved beach and shoreline habitats will also provide shelter from predators and food for young salmonids. Nourishment does not remove the physical forces that cause erosion but it does help to improve and restore habitats affected by erosion.

Sediment/Soil Remediation

Remediation of contaminated soil or sediment may occur in-water, nearshore, upland, or any combination thereof. For a remedial action to be carried out under SNNP, it must first have authorization, approval, or a positive recommendation from the appropriate state and/or federal authority approving the remediation action. Typically, this will be from the US Environmental Protection Agency, Washington Department of Ecology, or the PSET.

The purpose of remediation activities is to eliminate, remove, or isolate contaminants found in soils, sediments, or groundwater so that they cannot interact with biota or are reduced to levels below an exposure risk threshold. The means by which to achieve such objectives are typically accomplished through the following activities: (1)removal of contaminated soils and sediments by excavation (soils) or dredging (sediments): (2) isolation of contaminated soils and sediments through capping or other forms of burial: (3) removal of groundwater contaminants through groundwater pumping and treatment systems; and (4) in situ treatment of contaminants in soils, sediments, or groundwater through the introduction of agents that bind, degrade, consume, or otherwise render contaminants inert or less toxic.

Many of the potential effects associated with remediation activities are covered under the discussion of general construction practices and would include the applicable PDC. Remediation work differs from general construction activities due to the presence of the contaminant(s) being remediated and the specialized methods by which remediation will occur.

Dredging of in-water or seasonally inundated sediments is generally carried out by specialized dredging equipment and techniques. The use of clamshell dredges (or similar) are typically equipped with an "environmental bucket" and the rate of bucket movement through the water column is slowed to limit re-suspension and redistribution of contaminated sediments. Similarly, suction dredges may use a smaller diameter cutterhead, employ divers to assist with dredge operations, or modify dredge suction to limit re-suspension and redistribution of contaminated sediments. Regardless of method, all dredge spoils must be contained in a sealed receptacle (e.g., barge, container, off-site location) that will prevent spillage of dredged material back into the aquatic environment.

Dredging typically removes sediments to a depth where the contaminants no longer exceed risk thresholds. However, in some cases, the leave surface may still contain contaminants at higher concentrations than required risk thresholds. In such cases, a cap of clean material must be placed over the contaminated leave surface, in order to isolate the remaining contaminants and disrupt the exposure pathway to the aquatic environment and biota. Use of capping material, such as clean sand, could temporarily reduce benthic invertebrate abundance, but the area being capped would have been recently dredged, so macroinvertebrate abundance would already be low.

Potential effects to listed fish species and critical habitat are typically from the temporary resuspension of sediment and contaminants and the temporary loss of benthic forage species. As such, work area isolation and turbidity control measures are critical. Additionally, actions that promote the recolonization of dredged areas by benthic organisms may reduce the amount of time dredged areas become unsuitable for foraging use. Removal of contaminated sediment will result in permanent habitat improvement.

Remediation projects are likely to occur most frequently in industrial sites located in developed areas of Puget Sound. Although the remediation activities will temporarily expose some adult and juvenile salmonids and green sturgeon to elevated levels of contaminants, the long-term impacts on water quality are beneficial.

2.5.6 Effects on Critical Habitat

Critical habitat for PS Chinook salmon, Hood Canal summer-run Chum salmon, PS/GB Bocaccio and PS/GB Yelloweye rockfish, and SRKWs all occur within the action area for this programmatic consultation. PS steelhead do not have nearshore or marine habitat areas designated as critical. NMFS reviews effects on critical habitat affected by a proposed action by examining how the PBFs of critical habitat will be altered, and the duration of such changes, and the influence of these changes on the potential for the habitat to serve the conservation values for which it was designated.

In estuarine and marine areas, the features of designated habitat common to each of the listed fish species, with the exception of PS steelhead, are (a) water quality and (b) forage or prey. For Chinook and chum salmon (c) safe migration areas are a feature of critical habitat. For juvenile PS/GB bocaccio, and PS Chinook salmon, (d) nearshore habitat with suitable conditions for growth and maturation, including sub-aquatic vegetation, is a feature of critical habitat. Below is a summary of the effects of the proposed action on critical habitat PBFs. These effects are thoroughly reviewed above.

For SRKW, NMFS identified the following physical or biological features essential to conservation: (1) Water quality to support growth and development; (2) Prey species of sufficient quantity, quality and availability to support individual growth, reproduction and development, as well as overall population growth; and (3) Passage conditions to allow for migration, resting, and foraging.

Summary of the effects of the action on salmon critical habitat PBFs:

1. Estuarine areas
    a. Forage – Short-term reduction in forage due to dredging, sediment remediation, and construction activities. Enduing loss of some forage production due to

overwater structures and shoreline modification. Loss of forage quality and quantity due to introduction of contaminants from stormwater. Improved production of forage from habitat enhancement activities including wetland restoration and beach nourishment (improved quality forage fish spawning habitat).

   b. Free passage – Improvement of fish passage at culvert and bridge replacement sites. Lengthening of migration pathways in nearshore areas due to the repair, replacement, or construction of new overwater structures. Temporary disruption of free passage due to underwater noise from pile driving and construction.
   c. Natural cover – Loss of natural cover resulting from suppression of SAV due to over- and in-water structures.
   d. Salinity – no effect
   e. Water quality – Temporary water quality degradation, including increased turbidity, due to construction activities and dredging. Reduced dissolved oxygen and resuspension of contaminated sediments from construction activities. Introduction of contaminants from stormwater. SSNP requirements for treatment of stormwater reduce the amount of contaminants reaching the action area.
   f. Water quantity – no effect
2. <u>Nearshore marine areas</u>
   a. Forage – Short-term reduction in forage due to dredging, sediment remediation, and construction activities. Enduring loss of some forage production due to overwater structures and shoreline modification. Improved production of forage from habitat enhancement activities including wetland restoration and beach nourishment (improved quality forage fish spawning habitat).
   b. Free passage – Improvement of fish passage at culvert and bridge replacement sites. Lengthening of migration pathways in nearshore areas due to the repair, replacement, or construction of new overwater structures. Temporary disruption of free passage due to underwater noise from pile driving and construction. Construction of new or repair and replacement of overwater and in-water structures degrade this PBF by creating migration barriers.
   c. Natural cover – Loss of natural cover resulting from suppression of SAV due to over- and in-water structures.
   d. Water quantity – no effect
   e. Water quality – Temporary water quality degradation, including increased turbidity, due to construction activities and dredging. Reduced dissolved oxygen and resuspension of contaminated sediments from construction activities. Introduction of contaminants from stormwater. SSNP requirements for treatment of stormwater reduce the amount of contaminants reaching the action area.
3. <u>Offshore marine areas</u> – These undefined PBFs do not occur in the action area.

Summary of the effects of the action on rockfish critical habitat PBFs:

Critical habitat is designated in San Juan/Straits of Juan de Fuca, Whidbey Basin, Main Basin, Hood Canal, and South Puget Sound. In each location, the conservation value is high.

Essential features for juvenile bocaccio include habitats located in the nearshore with substrates such as sand, rock and/or cobble compositions that also support kelp are essential for conservation because these features enable forage opportunities and refuge from predators and enable behavioral and physiological changes needed for juveniles to occupy deeper adult habitats, with:

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

Nearshore areas are contiguous with the shoreline from the line of extreme high water out to a depth no greater than 30 meters (98 ft) relative to mean lower low water.

Essential features for adult bocaccio rockfish and yelloweye (adult and juvenile). Benthic habitats and sites deeper than 30 m (98 ft) that possess or are adjacent to areas of complex bathymetry consisting of rock and or highly rugose habitat are essential to conservation because these features support growth, survival, reproduction, and feeding opportunities by providing the structure for rockfish to avoid predation, seek food and persist for decades. Several attributes of these sites determine the quality of the habitat and are useful in considering the conservation value of the associated feature, and whether the feature may require special management considerations or protection. These attributes are also relevant in the evaluation of the effects of a proposed action in an ESA section 7 consultation if the specific area containing the site is designated as critical habitat. These 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 dissolved oxygen to support growth, survival, reproduction, and feeding opportunities; and
3. The type and amount of structure and rugosity that supports feeding opportunities and predator avoidance.

The proposed action is likely to adversely affect critical habitat for PS/GB bocaccio and yelloweye. These effects would be concentrated on the nearshore juvenile settlement habitats PBF. NMFS expects that the habitats at sites deeper than 98 feet (30 m) within the range of expected effects from the proposed action though at a lesser degree. The proposed action includes conservation offsets to compensate for the enduring effects on nearshore habitat quality.

a. Quantity, quality, and availability of prey species – The diet of Puget Sound rockfish consists of small prey items such as calanoid copepods, crab larvae, chaetognaths, hyperiid amphipods and siphonophores (Moulton 1977, Miller et al. 1978, in WDFW 2009). In South Sound, yelloweye rockfish feed on fishes, especially walleye pollock (*Theragra chalcogramma*), cottids, poachers, and Pacific cod (*Gadus macrocephalus*) (Washington et al. 1978, in WDFW 2009). The proposed action will cause short-term reduction in invertebrate and fish forage items due to dredging, sediment remediation, and construction activities. Enduing loss of some forage production due to overwater structures. Shoreline modification interrupts natural shoreline habitat forming processes and reduces the abundance of invertebrate and fish forage items. Loss of forage quality and quantity results from introduction of contaminants from stormwater. Improved production of forage from habitat enhancement activities including wetland restoration and beach nourishment (improved quality forage fish spawning habitat).

b. Water quality –Temporary water quality degradation, including increased turbidity, due to construction activities and dredging. Reduced dissolved oxygen and resuspension of contaminated sediments from construction activities. Introduction of contaminants from stormwater. SSNP requirements for treatment of stormwater reduce the amount of contaminants reaching the action area.

c. Structure and rugosity – Loss of natural cover resulting from suppression of SAV due to over- and in-water structures.

Summary of the effects of the action on SRKW critical habitat PBFs

The PBFs of SRKW critical habitat are: (1) Water quality to support growth and development; (2) Prey species of sufficient quantity, quality and availability to support individual growth, reproduction and development, as well as overall population growth; and (3) Passage conditions to allow for migration, resting, and foraging.

a. Water quality – Temporary water quality degradation, including increased turbidity, due to construction activities and dredging. Reduced dissolved oxygen and resuspension of contaminated sediments from construction activities and sediment remediation. Introduction of contaminants from stormwater can accumulate in prey as described below. SSNP requires treatment of stormwater reduce the amount of contaminants reaching the action area.

b. Prey – For SRKW, contaminants would reduce quality and quantity of prey including juvenile Chinook salmon. As PS Chinook salmon are a PBF of SRKW critical habitat, their repeated/chronic exposure to contaminants in successive cohorts, directly through diminished water quality, and via contaminated prey, both described above, results in a diminishment of the forage PBF of SRKW critical habitat. Both quantity and quality of prey will slightly decline as a result of impacts to water quality, as these effects are likely to cause latent health effects on fish that slightly reduce adult abundance, and also reduce the quality of adult fish that do return and serve as SRKW prey, due to bioaccumulated contaminants.

   Overwater and in-water structures reduce nearshore habitat quality, increase migration time, and increase predation on juvenile salmonids. Likewise, shoreline modification interrupts natural shoreline processes, degrading nearshore habitat. Over time, this reduces the amount of salmon available as forage for SRKWs. The SSNP proposed action includes conservation offsets to compensate for the loss of nearshore habitat quality. As a result, the projects authorized under SSNP will result in no-net loss of nearshore habitat quality.

   Given the total quantity of prey available to SRKWs throughout their range numbers in the millions, the reduction in prey related to short-term construction effects from the proposed action is extremely small. Therefore, NMFS anticipates that the short-term reduction of Chinook salmon from temporary effects would have little effect on SRKWs. Conservation offsets are proposed as part of SSNP to ensure no net loss of nearshore habitat in the Salish Sea. This will ensure the proposed action will not result in reduction of forage (salmon) due to degradation of nearshore habitat.

c. Passage conditions – The proposed action has the potential to affect passage conditions in SRKW designated critical habitat. Effects of the proposed action include the potential for exposure to the and sound generated by vessels associated with the proposed action. The increase in vessel presence and sound in SRKW critical habitat contribute to total effects on passage conditions. However, vessels associated with the proposed action do not target whales and disturbance would likely be transitory, including small avoidance movements away from vessels. As discussed above, considering the state and federal regulations in place, the number and spread of vessels is not expected to result in blocking movements of the whales in their travel corridors. Therefore, it is unlikely that any small transitory disturbance from vessels that might occur would have more than a very minor effect on passage in designated critical habitat. Lastly, given all projects that include impact or vibratory pile driving will include a Marine Mammal Monitoring Plan that is sufficient to ensure pile driving ceases before marine mammals enter the area where sound will exceed 120 dBRMS, effects from these activities on passage in SRKW critical habitat is likely minor.

2.5.7 Effects on Listed Species

Effects on listed species is a function of (1) the numbers of animals exposed to habitat changes or effects of an action; (2) the duration, intensity, and frequency of exposure to those effects; and (3) the life stage at exposure. This section presents an analysis of exposure and response.

As noted above in the effects on critical habitat, projects authorized under SSNP would have temporary, episodic, and enduring effects. Our exposure and response analysis identifies the multiple life stages of listed species that use the action area, and whether they would encounter these effects, as different life-stages of a species may not be exposed to all effects, and when exposed, can respond in different ways to the same habitat perturbations.

Period of Exposure to Temporary Effects

As described in Section 1.3 (Proposed Action), all in-water work would occur during the WDFW in-water work period. The in-water work periods for different locations are selected to coincide with the lowest fish abundance at that location. Scheduling in-water water work during these times significantly reduces the number of individual fish exposed to the temporary construction effects.

Juvenile Puget Sound Chinook salmon generally emigrate from freshwater natal areas to estuarine and nearshore habitats from January to April as fry, and from April through early July as larger sub-yearlings. However, juveniles have been found in PS neritic waters between April and November (Rice et al. 2011). The work windows avoid peak juvenile Chinook presence from mid-February through mid-July, but does not fully avoid exposure in January through the first half of February. Additionally, a substantial percentage of Chinook salmon rear in Puget Sound without migrating to ocean areas (O’Neill and West 2009).

Juvenile PS steelhead primarily emigrate from natal streams in April and May, and appear to move directly out into the ocean to rear, spending little time in the nearshore zone (Goetz et al. 2015). However, steelhead smolts have been found in low abundances in the marine nearshore, outside of their natal estuary, between May and August (Brennan et al. 2004), which overlaps with some in-water work windows. Juvenile steelhead will therefore be present in Puget Sound during the early part of some work windows, July 15 through August, however, because they enter the Sound after a longer freshwater residency, they are larger and less dependent on nearshore locations where work is going to occur. The proposed work window would minimize overlap of temporary construction effects with the presence in nearshore habitat of juvenile PS steelhead in the action area, but will not avoid all exposure.

Larval and Juvenile Rockfish. Larval rockfish presence peaks twice in the spawning period, once in spring and once in late summer. The in-water work window (July 15 to February 15) that is adhered to for salmon species makes it likely that during the fall spawning period large numbers of larval rockfish, both PS/GB bocaccio and yelloweye, will be exposed to construction effects, and thus exposed to sound and high turbidity and any associated contaminants or low dissolved oxygen.

Juvenile Hood Canal Summer run chum. In late winter, juvenile chum can spend up to one month in estuarine shallow waters (all salinity zones) before moving to the ocean. After leaving estuaries, juveniles may exhibit extended residency within Puget Sound before migrating, and may even overwinter in the Sound (Salo 1991, Johnson et al. 1997). Wait et al (2018) show widespread use of nearshore habitat by summer run chum, even at sites that are distant from natal streams. Migration rates of chum salmon in nearshore areas are variable and depend upon fish size, foraging success, and environmental conditions (currents and prevailing winds). Small chum salmon fry (< 50-60 mm) appear to migrate primarily along the shoreline in shallow water less than 2 meters in depth. Use of shallow water habitats relates to predator avoidance and prey availability. When present in shallow water habitats, juvenile chum salmon less than 60 mm consume primarily epibenthic invertebrates, particularly harpacticoid copepods and gammarid amphipods. These epibenthic prey are primarily associated with protected, fine-grained substrates, and often eelgrass, and are especially abundant early in the year in some locations. This suggests that these habitat types are especially important to small, early migrating chum salmon, some of which are presumably summer chum salmon. Exposure is likely among Hood Canal Summer run chum (Fresh 2006).

Juvenile Summary. Because exposure cannot be fully excluded by in-water work timing for juvenile salmonids, juvenile bocaccio, or larval bocaccio and yelloweye, we evaluate other factors influencing potential presence of these fish, and if present, the potential duration of their exposure. Juvenile Chinook salmon are however, have the longest period in which they are nearshore oriented (Fresh 2006) and thus, although numbers are expected to be low at any given time, individuals of this species are likely more often per individual to encounter the intertidal and nearshore area where construction and enduring structure effects are anticipated.

Adult salmonids. The presence of adult PS Chinook salmon and PS steelhead in PS overlaps with the proposed in-water construction window. Like adult PS Chinook salmon, adult PS steelhead occupy deep water, generally deeper than the location where the projects authorized under SSNP would be proposed. Thus, we expect the direct habitat effects from the overwater and in-water structures to create little exposure or response among adult PS Chinook salmon and PS steelhead as they do not rely on the nearshore. However, some data suggests that up to 70 percent of PS Chinook salmon spend their adult period in Puget Sound without migrating to the ocean (Kagley et al. 2016), suggesting that most adult PS Chinook will experience far reaching effects such as sound from pile driving, vessel noise, some water quality diminishments and reduced prey.

Adult Rockfish. The presence of adult PS/GB bocaccio and yelloweye in the action area is extremely low. Suitable habitat for this lifestage is extremely limited based on preferred habitat depths and features such as rugosity. However, given the ability of this species to move throughout the marine environment, we cannot conclude that they would not ever occur within the action area or during a construction action.

Southern Resident Killer Whales. Between the three pods that comprise this DPS, identified as J, K, and L, some members of the DPS are present in Puget Sound at any time of the year though data on observations since 1976 generally shown that all three pods are in Puget Sound June through September, which means that all are likely present in the during work windows that begins on July 15. As discussed in the Status section, the whales' seasonal movements are only somewhat predictable because there can be large inter-annual variability in arrival time and days present in inland waters from spring through fall. Late arrivals and fewer days present in inland waters have been observed in recent years. The likelihood of exposure to the temporary effects of construction are high (Olson et al. 2018). However, implementation of a marine mammal monitoring plan would greatly reduce the likelihood that SRKWs will actually experience negative effects from in-water construction.

A. Species Response to Temporary Effects

<u>Water Quality</u>
As described above, in-water construction, dredging, and sediment remediation will cause a temporary increase in the turbidity/suspended sediment levels, potential declines in DO, and temporary increases in pollutants such as PAHs. Elevated turbidity and TSS levels during construction could extend up to 200 feet radially from project location during construction, and would return to background levels shortly after the end of construction (hours to days). In most cases, the increase is expected to last for a few days to a few months. In some cases, and the increase could last for months or longer. As explained earlier, project locations are likely to be distributed across the Salish Sea and the likelihood that the area impacted by any project's temporary construction effects will overlap is very low. Although the impact on the species consider in this opinion can be meaningful, the total amount of habitat affected by increases in suspended sediments at any given time is tiny when compared to the amount of habitat available for these species.

<u>Fish Species Response</u>
The effects of suspended sediment on fish increase in severity with sediment concentration and exposure time and can progressively include behavioral avoidance and/or disorientation, physiological stress (e.g., coughing), gill abrasion, and death—at extremely high concentrations. Newcombe and Jensen (1996) analyzed numerous reports on documented fish responses to

suspended sediment in streams and estuaries, and identified a scale of ill effects based on sediment concentration and duration of exposure, or dose. Exposure to concentrations of suspended sediments expected during the proposed in-water construction activities could elicit sublethal effects such as a short-term reduction in feeding rate or success, or minor physiological stress such as coughing or increased respiration. Studies show that salmonids have an ability to detect and distinguish turbidity and other water quality gradients (Quinn 2005; Simenstad 1988), and that larger juvenile salmonids are more tolerant to suspended sediment than smaller juveniles (Servizi and Martens 1991; Newcombe and Jensen 1996).

Despite being present during a portion of the work window, juvenile PS steelhead are not nearshore dependent and so are not expected to be in the shallow water in large numbers. Those present are expected to be only briefly in the area where elevated suspended sediment would occur (within a 200-foot radius to account for the point of compliance for aquatic life turbidity criteria) and to have strong capacity as larger juveniles to avoid areas of high turbidity. To the degree that there is a contemporary decrease in DO within the same footprint, because steelhead are expected to have only brief exposure to the affected area, we do not anticipate a significant response to reduced DO. We accordingly consider their exposure to the temporary effects will not be sufficient to cause any injury or harmful behavioral response to juvenile PS steelhead.

Juvenile PS Chinook salmon and HCSR chum salmon are likely to be present during in-water construction activities and likely to be exposed to the temporary construction effects, most notably elevated levels of suspended sediment. The proposed minimization measures (i.e. only working in the dry) indicate that TSS levels will be only slightly elevated near the construction area and only during tidal inundations of the site during the project and during the first tidal inundation after completion of the project. Turbidity and TSS levels would return to background levels quickly and be localized to the in-water construction areas (200-foot radius turbidity mixing zone). Again, decreased DO is expected to be contemporaneous with and in the same footprint of the suspended sediment. While juvenile salmon are likely to encounter these areas, they can detect and avoid areas of high turbidity, and exposure is expected to be brief. Thus, duration and intensity of exposure of juvenile salmon is also unlikely to cause injury or a harmful response.

While there is little information regarding the habitat requirements of rockfish larvae, other marine fish larvae biologically similar to rockfish larvae are vulnerable to low dissolved oxygen levels and elevated suspended sediment levels that can alter feeding rates and cause abrasion to gills (Boehlert 1984; Boehlert and Morgan 1985; Morgan and Levings 1989). Because the work window will overlap with one peak in larval presence, which is a several month pelagic stage without significant capacity for avoidance behavior (larval rockfish can swim at a rate of roughly 2 cm per second (Kashef et al. 2014) but are likely passively distributed with prevailing currents (Kendall and Picquelle 2003)), we can assume that project sites will have areas of high turbidity, and that larvae can be present in significant numbers (PS/GB bocaccio) that will be adversely affected.

Benthic Conditions/Forage Communities

In-water construction and dredging will temporarily reduce the availability of benthic prey items for salmon, steelhead, and rockfish. As explained earlier, disturbed areas will be recolonized and the loss of forage is a temporary impact. The annual amount of area with reduced benthic forage due to inwater construction and dredging is very small when compared to the available habitat in project areas.

Fish Species Response
As noted above, the area in which benthic forage base is temporarily diminished by disturbed substrate in any given year would be small compared to the amount of available habitat in any given project area and within the Salish Sea. Benthic prey recruits from adjacent areas move via tides and currents, and thus the prey base can re-establish in disturbed areas a matter of weeks. We expect only the cohorts of PS Chinook salmon, HCSR chum salmon, and PS steelhead that are present in the action area to be exposed to this temporary reduction of prey, and we expect that because prey is abundant in close proximity, feeding, growth, development and fitness of the individuals that are present during this brief habitat disruption from construction would not be affected. Therefore, we consider the temporary effects on any juvenile PS Chinook salmon, HCSR chum salmon, and PS steelhead in the action area to be unlikely to cause injury at the individual scale.

On the other hand, juvenile PS/GB bocaccio feed on the young of other rockfish, surfperch, and jack mackerel in nearshore areas (Love et al. 1991; Leet et al. 1992). Juveniles also eat all life stages of copepods and euphausiids (MacCall et al. 1999). Because juvenile rockfish are less able to access adjacent areas compared with salmon species, reductions in benthic prey communities, and in SAV from disturbance in work areas will reduce available forage for PS/GB bocaccio in their nearshore settlements, reducing growth and fitness of a small number of affected individuals at each location.

SRKW Response
The reduction in prey (PS Chinook salmon) from the temporary construction effects of the SSNP proposed action is extremely small even when considered across the action area, due to the application of work windows to avoid peak presence of this species at the juvenile life stage and the other reasons discussed above. As mentioned above, diet data suggest that SRKWs are consuming mostly larger (i.e., generally age 3 and up) Chinook salmon (Ford and Ellis 2006). Given the total quantity of prey available to SRKWs throughout their range, this short-term reduction in prey that results from the temporary construction effects is extremely small. It is also likely that only a small percent of impacted juvenile salmon would survive to the age that they would be prey for SRKW. Because the annual reduction would be small, there is also a low probability that any of the Chinook salmon killed from the short-term impacts caused by implementation of the proposed action would be intercepted by the killer whales across their vast range in the absence of the proposed action. Therefore, NMFS anticipates that the short-term reduction of Chinook salmon during construction would have little effect on SRKWs.

Construction Noise
In-water water construction and dredging create in-water noise through vessel use and pile driving. As explained earlier, most in-water noise will occur at levels that would disrupt normal behaviors such as feeding and sheltering. In-water noise from impact pile driving can cause injury or death; however, the general construction measures proposed as part of SSNP would reduce the likelihood of this occurring.

Fish Species Response

Many projects authorized under SSNP will include pile driving. Only those that have impact pile driving will generate sound loud enough to directly injure or kill fish. Vibratory pile driving can generate noise levels that fish detect and respond to, including above the 150 Db behavioral threshold but well below the thresholds for physical injury (Erbe and McPherson 2017). Fish may exhibit behavioral responses to vibratory driving.

Where piles are to be replaced, the piles may be installed either a vibratory or an impact hammer or a combination of both. When impact driving or proofing steel piles, a bubble curtain will be used to attenuate the energy. Some projects may exclusively use a vibratory hammer to drive the piles. However, in order to ensure that the pile will be able to support the weight of construction equipment or to overcome difficult substrates, applicants may finish driving each pile with an impact hammer.

Pile driving can cause high levels of underwater sound. This noise from impact pile driving can injure or kill fish and alter behavior (Turnpenny et al. 1994; Turnpenny and Nedwell 1994; Popper 2003; Hastings and Popper 2005). Death from barotrauma can be instantaneous or delayed up to several days after exposure. Even when not enough to kill fish, high sound levels can cause sublethal injuries. Fish suffering damage to hearing organs may suffer equilibrium problems, and may have a reduced ability to detect predators and prey (Turnpenny et al. 1994; Hastings et al. 1996). Hastings (2007) determined that a cumulative Sound Exposure Level (cSEL) as low as 183 dB (re: 1 µPa2-sec) was sufficient to injure the non-auditory tissues of juvenile spot and pinfish with an estimated mass of 0.5 grams.

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

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

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

We cannot predict the number of individual fish that will be exposed because of high variability in species presence at any given time. Furthermore, not all exposed individuals will experience adverse effects. We expect that some individuals of listed fish species will experience sublethal effects, such as temporary threshold shifts, or behavior responses to underwater noise for each of the projects that includes pile driving.

With regard to vibratory driving and noise from construction vessels, the behavioral effects from anthropogenic sound exposure remains poorly understood for fishes, especially in the wild. NMFS applies a conservative threshold of 150 dB rms (re 1 μPa) to assess potential behavioral responses of fishes from acoustic stimuli. Fewtrell (2003) observed fish exposed to air gun noise exhibited alarm responses from sound levels of 158 to 163 dB (re 1 μPa). More recently, Fewtrell and McCauley (2012) exposed fishes to air gun sound between 147-151 dB SEL and observed alarm responses in fishes.

The above-discussed criteria specifically address fish exposure to impulsive sound. Stadler and Woodbury (2009) make it clear that the thresholds likely overestimate the potential for impacts on fish from non-impulsive sounds (e.g., vibratory pile driving). Non-impulsive sounds have less potential to cause adverse effects in fish than impulsive sounds. Impulsive sources cause short bursts of sound with very fast rise times and the majority of the energy in the first fractions of a second. Whereas, non-impulsive sources cause noise with slower rise times and sound energy that is spread across an extended period of time; ranging from several seconds to many minutes in duration. Regarding noise from boat motors, some fish species have been noted to not respond to outboard engines, others respond with increased stress levels, and sufficient avoidance as to decrease density (Whitfield and Becker 2014).

Use of construction vessels generates noise that can interrupt normal behavior patterns in salmon and steelhead. In particular, we expect that juvenile PS Chinook salmon and HCSR chum salmon migration and foraging would be affected by construction vessel noise. At most project sites, construction would last for a few days up to a few weeks. At larger commercial or industrial sites, constructions may last for months or longer. We expect most juvenile would avoid the area or enter the area and experience increases stress levels. Although very few fish are expected to die as a result of exposure to construction noise, a small number of fish would experience a loss of fitness as a result of this exposure.

Work windows are generally designed to prevent work from occurring during peak presence of salmonids, but do not guarantee that exposure will not occur. Juvenile Chinook will have the most exposure due to their extensive use of nearshore habitats. Juvenile HCSR chum salmon also depend on estuarine and nearshore habitats, but they migrate more rapidly out of Puget Sound. Adult Chinook, adult and juvenile steelhead, and adult chum salmon make little use of nearshore habitats, and will be exposed to injurious levels of underwater sound in very small numbers. Larval yelloweye rockfish and larval and juvenile PS/GB bocaccio will also be exposed in uncertain numbers. During the WDFW in-water work windows, all exposed PS Chinook salmon, PS steelhead, and adult HCSR chum individuals will be at least two grams, which reduces the likelihood of lethal response. Larval rockfish, younger juvenile PS/GB bocaccio, and younger chum salmon will be less than two grams, making them more vulnerable to lethal response.

We cannot estimate the number of individuals from any species that will experience adverse effects from underwater sound, nor predict the specific responses among the fish exposed. Not all exposed individuals will experience adverse effects, some will experience sublethal effects, such as temporary threshold shifts, some merely behavior responses such as startle. Physical injury from barotrauma, and death are also possible. However, because the projects will occur across a variety of locations in Puget Sound, we anticipate that multiple individual fish from multiple populations of the various species will be adversely affected, up to and including death of some individuals.

<u>SRKW Response</u>

SRKWs could be injured or disturbed by sound pressure generated by pile driving. NMFS uses conservative thresholds of sound pressure levels from broad band sounds that cause behavioral disturbance (160dBrms re: 1µPa for impulse sound and 120 dBrms re: 1µPa for continuous sound) and injury (for impulsive: peak SPL flat weighted 230 dB, weighted cumulative SEL 185 dB; for non-impulsive: weighted cumulative SEL 198 dB) (NMFS 2018). However, criteria for marine mammal monitoring and stop-work on sighting of SRKW is intended to ensure that SRKW will not experience duration or intensity of pile driving, either impact or vibratory, that would result in disturbance or harm to any individual of this species. SRKW response to vessel noise (whether it be barges, personal power boats, or shipping freights) are discussed in more detail below

<u>Species Response to Intermittent and Enduring Effects</u>

As was detailed in sections above, the proposed overwater and in-water structures would cause an array of negative impacts to intertidal and nearshore habitat availability and function, along with more system-wide detriments associated with the use of the structures. Once repaired, replaced, or newly constructed, the structures would be expected to remain in the aquatic environment for a 40- to 50-year period. Thus, multiple cohorts of the multiple populations of PS Chinook salmon, PS steelhead, Hood Canal summer-run Chum, PS/GB bocaccio rockfish, PS/GB Yelloweye rockfish, and SRKW would experience the long-term habitat modifications associated with the presence of the structures. The requirement to offset the impacts of overwater and in-water structures, shoreline modification, and dredging through the conservation offsets is expected to compensate for the loss of nearshore habitat quality.

Effects on listed species is a function of: (1) the numbers of fish exposed to habitat changes or direct effects of an action; (2) the duration, intensity, and frequency of exposure to those effects; and (3) the life stage at exposure. This section presents an analysis of exposure and response both to habitat effects, and some effects that occur directly on species.

B. Species Response to Intermittent Effects

<u>Response to Water Quality Reductions—Suspended Sediments</u>
Some projects will support vessels transit to and from ports, marinas, docks and piers. Vessel propwash can occur at any time causing and increases in turbidity and suspended sediment levels levels. For this reason, individual juvenile and adult salmonids, larval rockfish, and juvenile PS/GB bocaccio are all likely to be exposed at any time, and multiple exposures at individual and population scales are reasonably expected.

<u>Fish Species Response</u>
The effects of suspended sediment on fish increase in severity with sediment concentration and exposure time and can progressively include behavioral avoidance and/or disorientation, physiological stress (e.g., coughing), gill abrasion, and death (at extremely high concentrations). Newcombe and Jensen (1996) analyzed numerous reports on documented fish responses to suspended sediment in streams and estuaries, and identified a scale of ill effects based on sediment concentration and duration of exposure, or dose. Exposure to concentrations of suspended sediments could elicit sublethal effects such as a short-term reduction in feeding rate or success, or minor physiological stress such as coughing or increased respiration. Studies show that salmonids have an ability to detect and distinguish turbidity and other water quality gradients (Quinn 2005; Simenstad 1988), and that larger juvenile salmonids are more tolerant to suspended sediment than smaller juveniles (Servizi and Martens 1991; Newcombe and Jensen 1996).

<u>Response to Water Quality Reduction—Reduced Dissolved Oxygen</u>
At stated above, increases of TSS can also produce localized reductions in DO. Sub-lethal effects of DO levels below saturation can include metabolic, feeding, growth, behavioral, and productivity effects. Behavior responses can include avoidance and migration disruption (NOAA Fisheries 2005). These effects are likely to occur contemporaneously with a subset of the events described above. As such it is expected that low DO exposure will occur in multiple locations each year, and will adversely affect multiple listed fish species at multiple life stages with the exception of adult PS/GB bocaccio, and juvenile and adult PS/GB yelloweye rockfish.

<u>Response to Water Quality Reduction—Contaminants</u>
The discharge of stormwater, removal or creosote piles, and intermittent discharges of contaminants from vessels would reduce water quality. The PDC and other requirements of SSNP will reduce, but not eliminate the intermittent introduction of contaminants.

<u>Fish Species Response</u>
Stormwater discharge. Some project authorized under SSNP will cause stormwater to be discharged to the Salish Sea. Stormwater can discharge at any time of year, with the potential to expose individual PS Chinook salmon (juvenile and adult), and PS/GB bocaccio and yelloweye (larval, juvenile, and adult) within this action area. All stormwater discharge is expected to contain levels of constituents and chemical mixtures that are toxic to fish and aquatic life (NMFS 2012, or "Oregon Toxics Opinion"). The Oregon Toxics Opinion concluded that for chronic saltwater criteria for metal compounds, fish exposed to multiple compounds, versus a single compound exposure, are likely to suffer toxicity greater than the assessment effects (*e.g.*, 50

percent mortality) such as mortality, reduced growth, impairment of essential behaviors related to successful rearing and migration, cellular trauma, physiological trauma, and reproductive failure. In addition to metals, listed species will be exposed to other contaminants including PAHs and 6PPD-quinone.

Stormwater runoff is a major contributing factor to water quality impairments throughout Washington State. Impervious surfaces, such as roads and parking lots, alter the natural infiltration of vegetation and soil, and accumulate many diverse pollutants. During heavy rainfall or snowmelt events, accumulated pollutants are mobilized and transported in runoff from roads and other impervious surfaces. Individual stormwater outfalls ultimately discharge to streams, rivers, lakes, and marine waters. Hence, cumulative stormwater inputs from multiple longitudinal outfalls can ultimately degrade habitat conditions (water quality) for salmon and other aquatic species at a watershed or sub-basin scale. These impacts also extend to physical habitat processes; for example, the hydrologic effects of stormwater runoff increase erosion and streambank scouring, downstream sedimentation and flooding, and channel simplifications (Jorgensen et al. 2013). Motor vehicles are the primary source of transportation-related pollutants from impervious surfaces. Known toxicants include those derived from tire wear (e.g., 6PPD-quinone), brake pads (e.g., copper and other metals), and exhaust (e.g., phenanthrene and other polycyclic aromatic hydrocarbons, or PAHs). Stormwater may also include additional contaminants depending on the surrounding land use and proximity to industrial facilities.

Stormwater can discharge at any time of year. However, first-flush rain events after long dry periods typically occur in September in western Washington. As with stormwater runoff globally, the leading edge of hydrographs (the first flush) in Puget Sound have proportionally higher contractions of contaminants, including those long known to resource managers (as evidenced by existing aquatic life criteria under the Clean Water Act), as well as many chemicals of emerging concern, so-called because they were largely unknown a decade ago (Peter et al. 2020). Higher concentrations of pollutants occur less frequently between March and October as longer dry periods exist between storm events. In western Washington, most stormwater discharge occurs between October and March, when the region receives the most rain.

In an examination of effect on juvenile salmon, McIntyre et al (2015) exposed sub yearling coho salmon to urban stormwater. One hundred percent of the juveniles exposed to untreated highway runoff died within 12 hours of exposure. McIntyre et al (2018) later examined the prespawn mortality rate of coho salmon exposed to urban stormwater runoff. In their experiments one hundred percent of coho salmon exposed to stormwater mixtures expressed abnormal behavior (lethargy, surface respiration, loss of equilibrium, and immobility) within 2 to 6 hours after exposure. Recent studies have shown that coho salmon show high rates of pre-spawning mortality when exposed to chemicals that leach from tires (McIntyre et al. 2015). Researchers have recently identified a tire rubber antioxidant as the cause (Tian et al. 2020). Although Chinook did not experience the same level of mortality, tire leachate is still a concern for all salmonids. Traffic residue also contains many unregulated toxic chemicals such as pharmaceuticals, polycyclic aromatic hydrocarbons (PAHs), fire retardants, and emissions that have been linked to deformities, injury and/or death of salmonids and other fish (Trudeau 2017; Young et al. 2018).

General construction measure 13 requires a comprehensive approach to stormwater management for projects that cause the discharge of stormwater, addressing both the quality and quantity of stormwater discharged from impervious surfaces. This approach will greatly reduce, but not eliminate the level of contaminants in discharged stormwater. As described earlier, contaminants in stormwater have a wide range of effects on fish. Chemicals such as 6PPD-quinone can kill coho salmon and may have adverse effects on other types of salmon. PAHs are carcinogenic and depending on exposure can cause a range of effects to fish ranging from lethal to sublethal. Cardiac disruption in fish is common following PAH exposure; juvenile fish with developing cardiac function are particularly susceptible to PAH toxicity (Incardona et al. 2011). Similarly, PAHs can cause narcosis and chronic sublethal effects to aquatic organisms at low levels of exposure and easily bioaccumulate across food webs (Bravo et al. 2011; Zhang et al. 2017; Neff 1985; Varanasi et al. 1985; Meador et al. 1995). Heavy metals, such as copper, zinc, cadmium, and mercury, can have a range of acute and chronic physiological and behavior effects on fish. Recent literature demonstrates that exposure to stormwater pollutants such as petroleum-based hydrocarbons and metals can affect salmonids, with effects ranging from avoidance to mortality depending on pollutant concentrations and synergistic effects (Feist et al. 2011; Gobel et al. 2007; McIntyre et al. 2012; Meadore et al. 2006; Sandahl et al. 2007; Spromberg et al. 2016).
Creosote. Some projects authorized under SSNP will remove creosote-treated piles and other creosote-treated timber. Creosote-treated piles contaminate the surrounding sediment up to two meters away with PAHs (Evans et al. 2009). The removal of the creosote-treated piles mobilizes these PAHs into the surrounding water and sediments (Smith et al. 2008; Parametrix 2011). Projects can also release PAHs directly from creosote-treated timber during the demolition of overwater timber and if any of the piles break during removal (Parametrix 2011). The concentration of PAHs released into surface water rapidly dilutes. Smith et al. (2008) reported concentrations of total PAHs of 101.8 μg/l 30 seconds after creosote-pile removal and 22.7 μg/l 60 seconds after. However, PAH levels in the sediment after pile removal can remain high for six months or more (Smith et al. 2008). Romberg (2005) found a major reduction in sediment PAH levels three years after pile removal contaminated an adjacent sediment cap.

Because they are shoreline-oriented and spend a greater amount of time within the action area, juvenile Chinook salmon will have the highest probability of exposure to PAHs. Juvenile chum also depend on estuarine and nearshore habitats, but they migrate more rapidly out of Puget Sound. We cannot discount the probability of adult and juvenile steelhead and adult Chinook and chum salmon exposure. Larval and juvenile PS/GB bocaccio and larval yelloweye rockfish could also be exposed. We cannot predict the number of fish that will be exposed to PAHs. The numbers of each species within the action area varies year to year. NMFS also cannot, with any meaningful level of accuracy, estimate the proportion of fish each year that will enter the impact zones. The magnitude of the exposure among some fish will greatly increase during the removal of these structures. We expect increased PAHs in the water column and sediments will remain within the area of increased suspended sediment caused by the project within 200 feet of creosote pile removal and structure demolition, and we do not expect fish to engage in avoidance behaviors within this area once suspended sediment from construction effects have dropped to baseline levels. Within three years after construction, the removal of the creosote-treated timber will begin to reduce the intensity of exposure of listed-fish, and exposure to PAHs at these sites would continue to decline over the long-term. As with PAHs found in stormwater, PAHs released from creosote piles can cause a range of effects to fish ranging from lethal to sublethal.

Vessels. Species will also be exposed to contaminants in oils and fuels, and PAHs from vessel operations, whether commercial or recreational, that transit to and from each of marinas, piers, wharfs, docks, floats, or boat ramps. These exposures are likely to be highest in the areas where use is concentrated, and more dilute throughout the remainder of the Sound where the vessels transit. Some individuals with each cohort of each species will be exposed annually via exhaust and incidental introduction of fuels and oils from vessels.

There are two pathways for PAH exposure to listed fish species in the action area, direct uptake through the gills and dietary exposure (Lee and Dobbs 1972; Neff et al. 1976; Karrow et al. 1999; Varanasi et al. 1993; Meador et al. 2006; McCain et al. 1990; Roubal et al. 1977). Fish rapidly uptake PAHs through their gills and food but also efficiently remove them from their body tissues (Lee and Dobbs 1972; Neff et al. 1976). Juvenile Chinook salmon prey, including amphipods and copepods, uptake PAHs from contaminated sediments (Landrum and Scavia 1983; Landrum et al. 1984; Neff 1982). Varanasi et al. (1993) found high levels of PAHs in the stomach contents of juvenile Chinook salmon in the Duwamish estuary. The primary response of exposed salmonids, from both uptake through their gills and dietary exposure, are immunosuppression and reduced growth. Karrow et al. (1999) characterized the immunotoxicity of creosote to rainbow trout (*O. mykiss*) and reported a lowest observable effect concentration for total PAHs of 17 µg/l. Varanasi et al. (1993) found greater immune dysfunction, reduced growth, and increased mortality compared to control fish. In order to isolate the effects of dietary exposure of PAHs on juvenile Chinook salmon, Meador et al. (2006) fed a mixture of PAHs intended to mimic those found by Varanasi et al. (1993) in the stomach contents of field-collected fish. These fish showed reduced growth compared to the control fish. Of the listed fish exposed to PAHs and other contaminants, all are likely to have some degree of immunosuppression and reduced growth, which, generally, increases the risk of death. As a result, some listed fish are expected to die but most will experience sublethal physiological effects from exposure to PAHs.

<u>SRKW Response</u>
Water quality supports SRKW's ability to forage, grow, and reproduce free from disease and impairment. Water quality is essential to the whales' conservation, given the whales' present contamination levels, small population numbers, increased extinction risk caused by any additional mortalities, and geographic range (and range of their primary prey) that includes highly populated and industrialized areas. Water quality is especially important in high-use areas where foraging behaviors occur and contaminants can enter the food chain. Water quality impaired by contaminants can inhibit reproduction, impair immune function, result in mortalities, or otherwise impede the growth and the species' recovery. The proposed action would expose SRKW to contaminants; however, the proposed action also contains multiple design criteria and general construction measures intended to reduce the level of contaminants reaching the waters of the Salish Sea.

SRKW can be exposed to contaminants directly (e.g. oil spills), or indirectly when their prey are contaminated through their own exposure to reduced water quality. For example, Chinook salmon contain higher levels of some persistent pollutants than other salmon species, but only limited information is available for pollutant levels in Chinook salmon (Krahn et al. 2007; O'Neill and West 2009; Veldhoen et al. 2010; Mongillo et al. 2016). These harmful pollutants, through consumption of prey species that contain these pollutants, are stored in the killer whale's blubber and can later be released; when the pollutants are released, they are redistributed to other tissues when the whales metabolize the blubber in response to food shortages or reduced acquisition of food energy that could occur for a variety of other reasons. The release of pollutants can also occur during gestation or lactation. Once the pollutants mobilize into circulation, they have the potential to cause a toxic response. Therefore, nutritional stress from reduced Chinook salmon populations may act synergistically with high pollutant levels in SRKW and result in adverse health effects.

Various adverse health effects in multiple species have been associated with exposures to persistent pollutants. These pollutants have the ability to cause endocrine disruption, reproductive disruption or failure, immunotoxicity, neurotoxicity, neurobehavioral disruption, and cancer (Reijnders 1986, de Swart et al. 1996, Subramanian et al. 1987, de Boer et al. 2000; Reddy et al. 2001, Schwacke et al. 2002; Darnerud 2003; Legler and Brouwer 2003; Viberg et al. 2003; Ylitalo et al. 2005; Fonnum et al. 2006; Viberg et al. 2006; Darnerud 2008; Legler 2008; Bonefeld-Jørgensen et al. 2011). Southern Residents are exposed to a mixture of pollutants, some of which may interact synergistically and enhance toxicity, influencing their health. High levels of these pollutants have been measured in blubber biopsy samples from Southern Residents (Ross et al. 2000; Krahn et al. 2007; Krahn et al. 2009), and more recently, these pollutants were measured in fecal samples collected from Southern Residents (Lundin et al. 2016a; Lundin et al. 2016b).

It is expected that SRKW prey species in the action area (i.e., PS Chinook salmon) will be exposed to and bio-accumulate contaminants through the proposed actions TSS, creosote pile removal and stormwater discharge (a pathway for exposure of persistent pollutants such as PCBs). The majority of SRKWs have high levels of PCBs (Ross et al. 2000; Krahn et al. 2007, 2009) that exceed a health-effects threshold (17,000 ng/g lipid) derived by Kannan et al. (2000) and Ross et al. (1996) for PCBs in marine mammal blubber. The PCB health-effects threshold is associated with reduced immune function and reproductive failure in harbor seals (Reijnders 1986; de Swart et al. 1996; Ross et al. 1996; Kannan et al. 2000). Moreover, juvenile SRKWs have blubber concentrations that are currently 2 to 3.6 times higher than the established health-effects threshold (Krahn et al. 2009).

Since the contaminant exposure is considered to be chronic and on-going, it is also expected a SRKW will consume at least some of the exposed and contaminated fish, adversely impacting SRKW health and fitness. The proposed action reduces the time until persistent pollutants (e.g. PCBs from stormwater) will surpass a health-effects threshold (i.e., PCB accumulation over the lifetime of a killer whale will occur more rapidly with the action than without it). Increasing persistent pollutant levels in the whales only further exacerbates their current susceptibility to adverse health effects.

Response to Water Quality Reduction—Vessel Noise

The number of marine watercraft is increasing—from private boats in coastal areas to commercial ships crossing oceans. A concomitant increase in underwater noise has been reported in several regions around the globe. Given the important role sound plays in the life functions of marine mammals, research on the potential effects of vessel noise has grown—in particular since the year 2000. Studies have been patchy in terms of their coverage of species, habitats, vessel types, and types of impact investigated. The documented effects include behavioral and acoustic responses, auditory masking, and stress (Erebe et al. 2019). Small crafts with high-speed engines and propellers generally produce higher frequency sound than large vessels (Erbe 2002, Erbe et al. 2013). Large vessels, including the cruise ships and tour vessels, generate substantial low frequency noise (Arveson and Vendittis 2000). Studies have shown that underwater-radiated noise from commercial ships may have both short and long-term negative consequences on marine life, especially marine mammals.

<u>Fish Species Response</u>
The noise related to commercial vessel traffic and recreational boating caused by the proposed action is likely to adversely affect Chinook salmon, HCSR chum, steelhead, and rockfish. Increased background noise has been shown to increase stress in fish (Mueller 1980; Scholik and Yan 2002; Picciulin et al. 2010). Recreational boat noise diminished the ability of resident red-mouthed goby (*Gobius cruentatus*) to maintain its territory (Sebastianutto et al. 2011). Xie et al. (2008) report that adult migrating salmon avoid vessels by swimming away. Graham and Cooke (2008) studied the effects of three boat noise disturbances (canoe paddling, trolling motor, and combustion engine (9.9 horsepower) on the cardiac physiology of largemouth bass (*Micropterus salmoides*). Exposure to each of the treatments resulted in an increase in cardiac output in all fish, associated with a dramatic increase in heart rate and a slight decrease in stroke volume, with the most extreme response being to that of the combustion engine treatment (Graham and Cooke 2008). Recovery times were the least with canoe paddling (15 minutes) and the longest with the power engine (40 minutes). Graham and Cooke (2008) postulate that the fishes' reactions demonstrate that the fish experienced sublethal physiological disturbances in response to the noise propagated from recreational boating activities. There are few published studies that assess mortality from vessel traffic on fishes, but studies thus far indicate that ichthyoplankton, which could include rockfish, may be susceptible to mortality because they are unable to swim away from traffic and thus may be harmed by propellers and turbulence. One study found low overall mortality from traffic, but that larvae loss was size dependent and that smaller larvae were more susceptible to mortality (Tonnes et al. 2016).

We expect juvenile and adult life history stages of Chinook salmon, HCSR chum salmon, steelhead, will be exposed; larval and juvenile PS/GB bocaccio will be exposed to noise from vessels. Each species at each of these life stages will experience sublethal physiological stress. Adult PS/GB bocaccio, and all lifestages of yelloweye are not expected to experience stressful levels of noise from vessels because these species/lifestages occur along the sea floor in deep water, where we expect noise to have dissipated to ambient levels.

Some fish that encounter boating noise will likely startle and briefly move away from the area. A study of motorboat noise on damselfish noted an increase in mortality by predation (Simpson et al. 2016). While some fish species have been noted to not respond to outboard engines, others respond with increased stress levels, and sufficient avoidance as to decrease density (Whitfield and Becker, 2014), while others experience reduced forage success (Voellmy et al 2014) either by reducing foraging behavior, or because of less effective foraging behavior. When fish startle and avoid preferred habitats, both the predator and prey detection may be impaired for a short period of time (minutes up to one hour) following that response.

Taken together, it can be assumed that juvenile salmonids are likely to respond to episodes of motor boat noise with a stress and startle reaction that can diminish both predator and prey detection for a short period of time with each episode. Because of the intermittent nature of the disturbance and the ability for fish to recuperate when it occurs, we do not expect this effect to be meaningful to survival in adult or juvenile fish in every location where they encounter noise from recreational boating, though growth and fitness could be slightly diminished if they encounter frequent episodes of boat noise, such as at marinas, public boat launches, or commercial piers or wharfs.

As described in the baseline section, commercial and recreational vessel traffic occurs throughout the Salish Sea. We expect all life history stages of Chinook salmon, HCSR chum salmon, steelhead, and juvenile PS/GB bocaccio will be exposed to vessel traffic and will experience sublethal physiological stress. Given that adult yelloweye rockfish occur along the sea floor in deep water, we do not expect adult PS/GB bocaccio and yelloweye rockfish to be affected by noise from vessel traffic.

<u>SRKW Response</u>
As noted in Section 2.5.3, some of the projects covered under SSNP will cause future vessel use, often by third parties. Such vessel use and associated noise is expected to affect SRKW, but the magnitude of exposure and response depends on many factors including, (1) the number of future projects associated with commercial structures vs residential, recreational, or municipal; (2) vessel type; (3) vessel size; (4) vessel speed; (5) vessel use of sonar; (6) compliance with multiple state and federal regulations that govern vessel operations in the Salish Sea; (7) compliance with voluntary measures such as vessel speed reductions; (8) time of year vessels are operating; and (9) presence and proximity of SRKWs

Vessels used for a variety of purposes (commercial shipping, military, recreation, fishing, whale watching and public transportation) occur in inland waters of the SRKWs' range. Several studies in inland waters of Washington State and British Columbia have linked interactions of vessels and Northern and Southern Resident killer whales with short-term behavioral changes (see review in Ferrara et al. (2017)). These studies concluded that vessel traffic may affect foraging efficiency, communication, and/or energy expenditure through the physical presence of the vessels, underwater sound created by the vessels, or both.

Collisions of killer whales with vessel strikes are uncommon and have rarely been observed in Puget Sound. Across the Northeast Pacific, causes of death for stranded killer whales of various ages and ecotypes have included congenital defects, malnutrition and emaciation, infectious disease, bacterial infections, and trauma from blunt force trauma (Raverty et al. 2020a). The authors examined stranding reports from 2004-2013 within the North Pacific Ocean and Hawaii and determined cause of death for 53 stranded whales, 22 of which had a definitive diagnosis for cause of death. They reported on both proximate (process, disease, or injury that initiated process that led to death) and ultimate (final process that led to death) causes of death. They confirmed that three whales died from vessel strikes, including one SRKW (L98 who was habituated to humans), one transient, and one Norther Resident killer whale but none of those occurred within the Salish Sea. Three others died of blunt force trauma with unknown origin. No injuries or mortalities from vessel strikes to individual SRKWs are expected as a result of the proposed action.

Vessel sounds in inland waters are from large ships, ferries, tankers and tugs, as well as from whale watch vessels, and smaller recreational vessels. Commercial sonar systems designed for fish finding, depth sounding, and sub-bottom profiling are widely used on recreational and commercial vessels and are often characterized by high operating frequencies, low power, narrow beam patterns, and short pulse length (National Research Council 2003). Frequencies fall between 1 and 500 kiloHertz (kHz), which is within the hearing range of some marine mammals including killer whales and may have masking effects (i.e., sound that precludes the ability to detect and transmit biological signals used for communication and foraging).

Recently, there have been several studies that have characterized sound from ships and vessels as well as ambient noise levels in the inland waters (Bassett et al. 2012; McKenna et al. 2013; Houghton et al. 2015; Veirs et al. 2016). Bassett et al. (2012) assessed ambient noise levels in northern Admiralty Inlet (a waterway dominated by larger vessels). They found that vessel activity contributed most to the variability measured in the ambient noise and cargo ships contributed to the majority of the vessel noise budget. Veirs et al. (2016) estimated sound pressure levels for larger ships that transited through the Haro Strait, and found that the received levels were above background levels, and that underwater noise from ships extends up to high frequencies similar to noise from smaller boats. Commercial shipping was also identified as a significant source of low frequency ambient noise in the ocean, which has long-range propagation and therefore can be heard over long distances. Additionally, over the past few decades the contribution of shipping to ambient noise has increased by as much as 12dB (Hildebrand 2009). Ship noise was identified as a concern because of its potential to interfere with SRKWs communication, foraging, and navigation (Veirs et al. 2016). In a study that measured ambient sound in a natural setting, SRKWs increased their call amplitude in a 1:1 dB ratio with louder background noise, which corresponded to increased vessel counts (Holt et al. 2009) (Holt et al. 2009). It should be noted that vessel speed also strongly predicts received sound levels by the whales (Holt et al. 2017) (Holt et al. 2017). Although there are several vessel characteristics that influence noise levels, vessel speed appears to be the most important predictor in source levels (McKenna et al. 2013; Houghton et al. 2015; Veirs et al. 2016; Holt et al. 2017), and reducing vessel speed would likely reduce acoustic exposure to SRKWs.

In 2017, the Vancouver Fraser Port Authority conducted a voluntary slow-down trial through Haro Strait (Joy et al. 2019). They determined that a speed limit of 11 knots would achieve positive noise reduction results without compromising navigational safety through the Strait. Hydrophones were deployed at sites adjacent to the northbound and southbound shipping lanes to measure noise levels through the trial period from August to October. During that period, 61 percent of piloted vessels, including bulk carriers, tugs, passenger vessels, container ships, and tankers, participated in the trial by slowing to 11 knots through the Strait. When compared to the pre-trial control period, the acoustic intensity of ambient noise in important SRKW foraging habitat off the west coast of San Juan Island was reduced by as much as 44% (corresponding to a 2.5 dB reduction in median sound pressure level) when vessels slowed down through Haro Strait (Joy et al. 2019). The results of this in situ trial show that vessel speed can be an effective target for the management of vessel impacts.

Recent evidence indicates there is a higher energetic cost of surface-active behaviors and vocal effort resulting from vessel disturbance in the Salish Sea (Williams et al. 2006; Noren et al. 2012; Noren et al. 2013; Holt et al. 2015). For example, Williams et al. (2006) estimated that changes in activity budgets in Northern Resident killer whales in British Columbia's inland waters in the presence of vessels result in an approximate 3% increase in energy expenditure compared to when vessels are not present. Other studies measuring metabolic rates in captive dolphins have shown these rates can increase during the more energetically costly surface behaviors (Noren et al. 2012) that are observed in killer whales in the wild, as well as during vocalizations and the increased vocal effort associated with vessels and noise (Noren et al. 2013; Holt et al. 2015). These studies show an increase in energy expenditure during surface active behaviors and changes in vocal effort may negatively impact the energy budget of an individual, particularly when cumulative impacts of exposure to multiple vessels throughout the day are considered.

However, this increased energy expenditure may be less important than the reduced time spent feeding and the resulting potential reduction in prey consumption (Ferrara et al. 2017). SRKWs spent 17 to 21% less time foraging in inland waters in the presence of vessels for 12 hours, depending on vessel distance (see (Ferrara et al. 2017)). Although the impacts of short-term behavioral changes on population dynamics is unknown, it is likely that because SRKWs are exposed to vessels the majority of daylight hours they are in inland waters, and that the whales in general spend less time foraging in the presence of vessels, there may be biologically relevant effects at the individual or population-level (Ferrara et al. 2017).

The Be Whale Wise viewing guidelines and the 2011 federal vessel regulations (www.bewhalewise.org) were designed to reduce behavioral impacts, acoustic masking, and risk of vessel strike to SRKWs in inland waters of Washington State. Since the regulations were codified, there is some evidence that the average distance between vessels and the whales has increased (Houghton 2014; Ferrara et al. 2017). The majority of vessels in close proximity to the whales are commercial and recreational whale watching vessels and the average number of boats accompanying whales can be high during the summer months (i.e., from 2013 to 2017 an average of 12 to 17 boats;(Seely 2016)). The average number of vessels with the whales decreased in 2018, 2019 and 2020 likely due to decreased viewing effort on SRKWs by commercial whale watching vessels, with an average of 10, 9, and 10.5 vessels with the whales at any given time, respectively (Frayne 2021). In 2019, the annual maximum number of total vessels observed in a ½ mile radius of the whales was 29, which was the lowest maximum number of vessels recorded by Soundwatch (Frayne 2021), the maximum in 2020 was 39 (Frayne 2021). However, fishing vessels are also found in close proximity to the whales and vessels that were actively fishing were responsible for 7% of the incidents inconsistent with the Be Whale Wise Guidelines and federal regulations in 2020 (Frayne 2021). In 2020, 92% of all incidents (inconsistent with Be Whale Wise guidelines and non-compliant with federal regulations, see (Frayne 2021)) of vessel activities were committed by private/recreational motor vessels, 4% private sailing vessels, 3% U.S. commercial vessels, <1% commercial kayaks, <1% Canadian commercial vessels (possibly related to closures due to COVID-19 orders) and <1% by commercial fishing vessels (Frayne 2021). An overall decrease in incidents was recorded in 2020, but incidents by private recreational vessels increased as the season progressed possibly in response to reductions in COVID-19 restrictions. These incidents included entering a voluntary no-go zone and fishing within 200 yards of the whales. A number of recommendations to improve compliance with guidelines and regulations are being implemented by a variety of partners to further reduce vessel disturbance (Ferrara et al. 2017).

Smaller fishing, recreational and commercial vessels are subject to existing federal regulations prohibiting approach to SRKW closer than 200 yards or positioning in the path of the whales within 400 yards (with exemptions for vessels lawfully engaged in commercial or treaty Indian fishing that are actively setting, retrieving, or closely tending fishing gear). State regulations also mandate protections for SRKWs (see RCW 77.15.740, mandating 300- to 400-yard approach limits, 7 knots or less speed within ½ nautical mile of the whales). Additionally, NMFS and other partners have outreach programs in place to educate vessel operators on how to avoid impacts to whales.

In Section 2.4, we noted that vessel-related noise has the potential to result in behavioral disturbance or harassment of SRKWs, including displacement, site abandonment (Gard 1974, Reeves 1977, Bryant et al.1984), masking (Richardson et al. 1995), alteration of diving or breathing patterns, and less responsiveness when feeding. Given the projected level of activity expected under SSNP (as explained in Section 1.2.1), the amount of any vessel traffic caused by the proposed action is expected to be a small fraction of the vessel traffic in the Salish Sea. In addition, as noted in the beginning of this description of the SRKW response, numerous factors will work to reduce the potential for SRKWs to be exposed to vessel traffic caused by this proposed action. In addition, we expect less than half of the projects covered under SSNP to cause some amount of commercial vessel traffic. Although vessel and acoustic disturbances by these kinds of vessels has the potential to cause short-term behavioral changes, avoidance, or a decrease in foraging, because of the nature and location of these vessels operations, and the fact that they are not targeting or approaching whales, we expect that any interactions, if they occur, will be transitory in nature and only cause a small amount of disturbance that is not likely to disrupt normal behavioral patterns or distribution, or cause harm to the whales. For other types of vessels, including recreational or whale watching vessels, we expect that the federal and state regulations and active monitoring of compliance, as well as the educational efforts discussed above, will work together to limit the exposure of SRKWs to vessel effects. Thus, although this level of vessel traffic has the potential to disrupt some SRKWs, we expect the exposure and response to be short term and minimal and to not disturb any essential behaviors patterns.

C. Species Response to Enduring Effects

Response to Habitat Disruptions from In-Water and Overwater Structures
Overwater and in-water structures cause migration delays in salmonids, increase predation on juvenile salmonids, reduce cover for salmonids and rockfish, and reduce the amount of forage available for these fish. SSNP requires conservation offsets to compensate for the loss of habitat quality caused by the construction of new as well as the repair and replacement of overwater and in-water structures.

Fish Species Response
Migration Disruption. In and overwater structures cause delays in migration for PS Chinook salmon from disorientation, fish school dispersal (resulting in a loss of refugia), and altered

migration routes (Simenstad 1999). Juvenile salmonids stop at the edge of the structures and avoid swimming into their shadow or underneath them (Heiser and Finn 1970; Able et al. 1998; Simenstad 1988; Southard et al. 2006; Toft et al. 2013). Swimming around structures lengthens the migration distance and is correlated with increased mortality. Anderson et al. (2005) found migratory travel distance rather than travel time or migration velocity has the greatest influence on the survival of juvenile spring Chinook salmon migrating through the Snake River 2005.

Juvenile salmon, in both the marine nearshore and in freshwater, migrate along the edge of shadows rather than through them (Nightingale and Simenstad 2001b; Southard et al. 2006; Celedonia et al. 2008a; Celedonia et al. 2008b; Moore et al. 2013; Munsch et al. 2014). In freshwater, about three-quarters of migrating Columbia River fall Chinook salmon smolts avoided a covered channel and selected an uncovered channel when presented with a choice in an experimental flume setup (Kemp et al. 2005). In Lake Washington, actively migrating juvenile Chinook salmon swam around structures through deeper water rather than swimming underneath a structure (Celedonia et al. 2008b). Structure width, light conditions, water depth, and presence of macrophytes influenced the degree of avoidance. Juvenile Chinook salmon were less hesitant to pass beneath narrower structures (Celedonia et al. 2008b).

In the marine nearshore, there is also substantial evidence that OWS impede the nearshore movements of juvenile salmonids (Heiser and Finn 1970; Able et al. 1998; Simenstad 1999; Southard et al. 2006; Toft et al. 2007). In the Puget Sound nearshore, 35-millimeter to 45-millimeter juvenile chum and pink salmon were reluctant to pass under docks (Heiser and Finn 1970). Southard et al. (2006) snorkeled underneath ferry terminals and found that juvenile salmon were not underneath the terminals at high tides when the water was closer to the structure, but only moved underneath the terminals at low tides when there was more light penetrating the edges. These findings show that overwater-structures disrupt juvenile migration in the Puget Sound nearshore. Juvenile Chinook and juvenile HCSR chum migrate along shallow nearshore habitats, and OWSs will disrupt their migration and increase their predation risk. Every juvenile Chinook and juvenile HCSR chum will encounter OWSs during their out-migration, and because the projects in this consultation are across Puget Sound, these structures will continue to be part of that migration disruption for fish in every year that they are present in the marine environment. Adult Chinook, adult and juvenile steelhead, adult chum, and juvenile PS/GB bocaccio do not migrate along shallow nearshore habitats. Therefore, OWS will not obstruct their movements.

Increased Predation Risk. An implication of juvenile salmon avoiding OWS is that some of them will swim around the structure (Nightingale and Simenstad 2001b). This behavioral modification will cause them to temporarily utilize deeper habitat, thereby exposing them to increased piscivorous predation. Hesitating upon first encountering the structure, as discussed, also exposes salmonids to avian predators that may use the floating structures as perches. Typical piscivorous juvenile salmonid predators, such as flatfish, sculpin, and larger juvenile salmonids, being larger than their prey, generally avoid the shallowest nearshore waters that outmigrant juvenile salmonids prefer—especially in the earliest periods of their marine residency. When juvenile salmonids temporarily leave the relative safety of the shallow water, their risk to being preyed upon by other fish increases. This has been shown in the marine environment where juvenile salmonid consumption by piscivorous predators increased fivefold when juvenile pink salmon were forced to leave the shallow nearshore (Willette 2001).

Further, swimming around OWS lengthens the salmonid migration route, which has been shown to be correlated to increased mortality. Migratory travel distance rather than travel time or migration velocity has been shown to have the greatest influence on survival of juvenile spring Chinook salmon migrating through the Snake River (Anderson et al. 2005). In summary, NMFS assumes that the increase in migratory path length from swimming around OWS as well as the increased exposure to piscivorous predators in deeper water likely will result in proportionally increased juvenile PS Chinook salmon and HCSR chum mortality.

Habitat modifications resulting from anthropogenic infrastructure including over water structures, (dams, bridges, locks) have been shown to inhibit movement of migrating salmon and cause unnaturally large aggregations. The aggregation of salmon has shown an increase in mortalities due to predation by marine mammals (Jeffries and Scordino 1997, Keefer et al. 2012, Moore et al. 2013).

Decreased Prey and Cover. OWS and associated boat use adversely affects SAV, if present. SAV is important in providing cover and a food base for juvenile PS Chinook, HCSR chum salmon, PS steelhead, and juvenile PS/GB bocaccio. Bax et al. (1978) determined the abundance of chum fry was positively correlated with the size of shallow nearshore zones, and sublittoral eelgrass beds have been considered to be the principal habitat utilized by the smaller. Overwater structures shade SAV (Kelty and Bliven 2003). Additionally, the turbidity from boat propeller wash decreases light levels (Eriksson et al. 2004). Shafer (1999; 2002) provides background information on the light requirements of seagrasses and documents the effects of reduced light availability on seagrass biomass and density, growth, and morphology.

Fresh et al. (2006a) researched the effects of grating in residential floats on eelgrass, a substrate for herring spawning, and a Chinook salmon forage species. They reported a statistically significant decline in eelgrass shoot density underneath six of the 11 studied floats in northern Puget Sound. However, the physiological pathways that result in the reduction in shoot density and biomass from shading applies to all SAV. Thus, it is reasonable to assume that shading from OWS adversely affects all SAV. A reduction to the primary production of SAV beds is likely to incrementally reduce the food sources and cover for juvenile PS Chinook, HCSR chum salmon, PS steelhead, and juvenile PS/GB bocaccio. The reduction in food source includes epibenthos (Haas et al. 2002) as well as forage fish. This reduction occurs in areas where smoltified salmonids have entered salt water and require abundant prey for growth, maturation and fitness for their marine life history stage.

The incremental reduction in epibenthic prey associated with the OWS projects will continue to reduce forage for listed fish production at each site. When salmonids from multiple cohorts from all populations have reduced prey availability and increased competition, it is reasonable to assume that the carrying capacity is constrained and abundance of these listed species will be curtailed or reduced. For these species, particularly because Chinook salmon as returning adults are prey of SRKW, this reduction constrains the prey availability for SRKW as well.

When PS/GB bocaccio rockfish reach sizes of 1 to 3.5 in (3 to 9 cm) or 3 to 6 months old, they settle into shallow, intertidal, nearshore waters in rocky, cobble and sand substrates with or without kelp (Love et al. 1991; Love et al. 2002). This habitat feature offers a beneficial mix of warmer temperatures, food, and refuge from predators (Love et al. 1991). Areas with floating and submerged kelp species support the highest densities of juvenile PS/GB bocaccio rockfish. OWS, then, by reducing prey communities and impairing SAV growth, diminish both values for PS/GB bocaccio, impairing their survival, growth, and fitness.

Species Response to Shoreline Modification

Armoring of shorelines with marine bulkheads or stabilizing materials such as riprap, interrupts natural shoreline habitat forming processes and reduces the quality of nearshore habitat. SSNP require conservation offsets to compensate for the loss nearshore habitat quality caused by shoreline modification.

Fish Species Response

Juvenile Chinook and juvenile HCSR chum migrate along shallow nearshore habitats, and bulkheads will degrade nearshore habitats and increase their predation risk. Every juvenile Chinook and juvenile HCSR chum will encounter armored beaches during their out-migration. As described in the effects on critical habitat, shoreline armoring reduces several nearshore habitat values, including reduced feeding opportunity, increased predation risk, and lack of shallow habitat areas particularly during high tides. We cannot estimate the number of individuals that will experience these effects from the shoreline armoring projects covered in this consultation.

Given that out-migrating juvenile salmonids (particularly Chinook salmon) use shallow-water habitats for rearing, foraging, and migration, bulkheads may potentially reduce growth and fitness of juvenile salmonid during this phase of their life history. In turn, the aggregate impact of this disruption among individuals over each year that these structures are in their habitat will amount to an overall reduction in survival rate because forcing juveniles into deeper water (when shore processes steepen beaches and truncate access to shallows during high tides), potentially affects their survival by exposing them to greater risk of predation while simultaneously limiting their prey resource availability along the shoreline (shallow littoral zone), thereby decreasing their feeding success and growth rate.

In addition, the alignment of some bulkheads will create or continue shading along the face of the wall, which further camouflages predators holding there from prey moving along the wall in waters lit by the sun. Such shaded areas create hiding areas for predators and prey that conceal them from fish in the lighted zone outside of the area impacted by the shaded area. Such behavior by fish creates a temporal and spatial overlap of predators and prey in the shaded zone, as well as enhancing the success of predator ambush attacks on prey outside of the shaded zone (Kahler et al. 2000, Carrasquero 2001).

Adult Chinook, adult and juvenile steelhead, adult chum, and juvenile PS/GB bocaccio do not migrate along shallow nearshore habitats. Therefore, bulkheads will not directly affect them. Impacts to SAV and epibenthic communities from shore steepening, and sediment coarsening will affect adult and juvenile Chinook, chum steelhead, and juvenile PS/GB bocaccio by available reducing forage. To the degree that rockfish spawn depends on SAV, their survival will also be reduced.

Species Response to Forage Reduction

Fish Species Response

Temporary, episodic, and enduring reductions in forage base, whether benthic prey communities or forage fish, will be caused by the repairs, replacements, expansions, or new construction of in and overwater structures and shoreline armoring. However, conservation offsets are required to compensate for the loss of nearshore habitat quality resulting from these activities. As a result we expect no net loss of nearshore habitat quality. Any loss of net loss of prey items for salmonids and rockfish are expected to be minor and not result in an observable impact of population abidance, productivity, spatial structure or diversity.

SRKW Response

The SSNP proposed action is carefully designed to avoid and minimize the effects of the proposed activities on PS Chinook salmon. SSNP also requires conservation offsets to compensate for any loss of nearshore habitat, a significant limiting factor for PS Chinook salmon. As a result, we do not expect he proposed action to result in any long-term loss of abundance, productivity, spatial structure or diversity for PS Chinook salmon. As such, we do not expect the proposed action to result in a long-term decrease in forage for SRKWs.

Effects on Population Viability

Fish Species Response

We assess the importance of effects of the proposed action to the ESUs/ DPS by examining the relevance of those effects to the characteristics of Viable Salmon Populations (VSPs). The characteristics of VSPs are sufficient abundance, population growth rate (productivity), spatial structure, and diversity. While these characteristics are described as unique components of population dynamics, each characteristic exerts significant influence on the others. For example, declining abundance can reduce spatial structure of a population when habitats are less varied diversity among the population declines. As described in detail above, the proposed action for SSNP includes design criteria and general construction measures to avoid or minimize the temporary and long-term effects of the proposed action. SSNP also requires conservation offsets to compensate for any loss of nearshore habitat. As a result, we do not expect the proposed action to result in any meaningful loss of abundance, productivity, spatial structure or diversity of any affected salmon or steelhead population.

SRKW Response

We review the population level effects on SRKW using the same parameters for viability, namely abundance, productivity, spatial structure, and distribution. This distinct population segment comprises three groups, J, K, and L pods. Abundance is low, (J pod = 24, K pod = 17, L pod =34) as of May, 2021. Productivity is likely to be impaired by the relatively high number of males to females. Spatial distribution has high inter-annual variability, and diversity is at risk because of the low abundance.

For SSNP, it is critical that the proposed action does not further reduce the abundance of PS Chinook salmon. As discussed above, we do not expect he proposed action to result in any long-term loss of abundance, productivity, spatial structure or diversity for PS Chinook salmon. We do not expect the proposed action to result in a long-term decrease in forage for SRKWs nor cause other adverse effects on SRKWs such that their abundance, productivity, spatial structure, and distribution will be negatively impacted.

2.6. Cumulative Effects

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

Some continuing non-federal activities are reasonably certain to contribute to climate effects within the action area. However, it is difficult if not impossible to distinguish between the action area's future environmental conditions caused by global climate change that are properly part of the environmental baseline *vs.* cumulative effects. Therefore, all relevant future climate-related environmental conditions in the action area are described in the environmental baseline (Section 2.4).

The action area, all waters of Puget Sound from Olympia, Washington at its southern end, to north of Bellingham, Washington, and to but not including the Strait of Juan de Fuca, is influenced by actions in the nearshore, along the shoreline, and also in tributary watersheds of which effects extend into the action area. Future actions in the nearshore and along the shoreline of Puget Sound are reasonably certain to include port and ferry terminal expansions, residential and commercial development, shoreline modifications, road and railroad construction and maintenance, and agricultural development. The repair, replacement, construction and removal of bulkheads above the HTL that may not require federal authorization will continue. Based on current trends, there could continue to be a net reduction in the total amount of shoreline armoring in Puget Sound (PSP 2018). Changes in tributary watersheds that are reasonably certain to affect the action area include reductions in water quality, water quantity, and sediment transport. Future actions in the tributary watersheds whose effects are reasonably certain to extend into the action area include operation of hydropower facilities, flow regulations, timber harvest, land conversions, disconnection of floodplain by maintaining flood-protection levees, effects of transportation infrastructure, and growth-related commercial and residential development. Some of these developments will occur without a federal nexus, however, most activities that occur waterward of the OHWM or HTL require a USACE permit and therefore involve federal activities.

All such future non-federal actions, in the nearshore as well as in tributary watersheds, will cause long-lasting environmental changes and will continue to harm ESA-listed species and their critical habitats. Especially relevant effects include the loss or degradation of nearshore habitats, pocket estuaries, estuarine rearing habitats, wetlands, floodplains, riparian areas, and water quality. We consider human population growth to be the main driver for most of the future negative effects on salmon and steelhead and their habitat.

When we consider a generic design life of structures in the proposed action, we can anticipate that docks, piers, ramps, and bulkheads, when maintained, are reasonably certain to remain in the environment for roughly 50 years. Thus, to gauge the cumulative effects accurately, we consider the non-federal effects that will occur in the action area within that same timeframe. As mentioned above, human populations are expected to increase within the Puget Sound region, and if population growth trends remain relatively consistent with recent trends, we can anticipate future growth at approximately 1.5 percent per year.[60]

The human population in the PS region increased from about 1.29 million people in 1950 to about 3.84 million in 2014, and is expected to reach nearly 5 million by 2040 (Puget Sound Regional Council 2020). As of the date of this Biological Opinion, the human population in the Puget Sound Region is 4.2 million, slightly exceeding projections. Thus, future private and public development actions are reasonably certain to continue in and around PS. As the human population continues to grow, demand for agricultural, commercial, and residential development and supporting public infrastructure is also reasonably certain to grow. We believe the majority of environmental effects related to future growth will be linked to these activities, in particular land clearing, associated land-use changes (i.e., from forest to impervious, lawn or pasture), increased impervious surface, and related contributions of contaminants to area waters. Land use changes and development of the built environment that are detrimental to salmonid habitats are reasonably certain to continue under existing regulations. Though the existing regulations minimize future potential adverse effects on salmon habitat, as currently constructed and implemented, they still allow systemic, incremental, additive degradation to occur.

In June 2005, the Shared Strategy presented its recovery plan for PS Chinook salmon and the Hood Canal Coordinating Council presented its recovery plan for Hood Canal summer-run chum salmon to NMFS who adopted and expanded the recovery plans to meet its obligations under the ESA. Together, the joint plans comprise the 2007 PS Chinook and Hood Canal summer-run chum Recovery Plan. Several not-for-profit organizations and state and federal agencies are implementing recovery actions identified in these recovery plans.

Multiple non-federal activities are reasonably certain to occur that impact SRKW interactions with vessels in the Salish Sea. These additional actions are designed to further reduce impacts from vessels on SRKW by limiting the potential for interactions including:

1. Washington State law (Senate Bill 5577) established a commercial whale watching license program and charged WDFW with administering the licensing program and developing rules for commercial whale watching for inland Washington waters (see RCW 77.65.615 and RCW 77.65.620). The new rules were adopted in December 2020, and became effective May 12, 2021, and include limitations on the time, distance, and area that SRKW can be viewed within ½ nautical mile, in an effort to reduce vessel and nose disturbance:
    a. The commercial whale watching season is limited to 3 months/year for viewing SRKW closer than ½ nautical mile, and is limited to 4 hours per day in the vicinity of SRKW.

[60] https://www.psrc.org/whats-happening/blog/region-adding-188-people-day

b. Up to 3 commercial whale watching vessels are allowed within ½ nautical mile of SRKW at a given time, with exclusion from approaching within ½ nautical mile of SRKW groups containing a calf.
c. Year-round closure of the "no-go" Whale Protection Zone along the western side of San Juan Island to commercial whale watching vessels, excluding a 100-yard corridor along the shoreline for commercial kayak tours.

2. Continued implementation and enforcement of the 2019 restrictions on speed and buffer distance around SRKW for all vessels.

3. Increased effort dedicated to outreach and education programs. This includes educational material for boating regulations, Be Whale Wise guidelines, the voluntary no-go zone, and the adjustment or silencing of sonar in the presence of SRKWs. Outreach content was created in the form of video, online (including social media), and print advertising targeting recreational boaters. On-site efforts include materials distributed at pumpout and re-fueling stations along Puget Sound, during Enforcement orca patrols, and signage at WA State Parks and WDFW water access sites. Additionally, State Parks integrated materials on whale watching regulations and guidelines in their boating safety education program to ensure all boaters are aware of current vessel regulations around SRKW.

4. Promotion of the Whale Report Alert System (WRAS) in Puget Sound, developed by the Ocean Wise Research Institute, which uses on-the-water reporting to alert large ships when whales are nearby. Reporting SRKW to WRAS is required for commercial whale watching license holders, and on-the-water staff are also being trained to report their sightings.

5. Piloting a new program ("Quiet Sound") that will have topic-area working groups to lead projects and programs on vessel operations, incentives, innovations, notification, monitoring, evaluation, and adaptive management. This effort was developed with partners including Commerce, WA State Ferries, and the Puget Sound Partnership in collaboration with the Ports, NOAA, and others. Funding is anticipated to be secured in the 2021 state legislative session.

6. Continued promotion of the voluntary "No-Go" Whale Protection Zone along the western side of San Juan Island in R-MA and C-MA7 for all recreational boats—fishing and non-fishing—and commercial fishing vessels (with the exception of the Fraser Panel sockeye and pink fisheries[61]) (Figure 17). The geographic extent of this area will stretch from Mitchell Bay in the north to Cattle Point in the south, and extend offshore ¼ mile between these locations. The voluntary "No-Go" Zone extends further offshore—out to ½ mile—from a point centered on Lime Kiln Lighthouse. This area reflects the San Juan County Marine Stewardship Area[62] extended in 2018 and the full protected area recognized by the Pacific Whale Watch Association[63] and is consistent with that

[61] Non-treaty Fraser River Panel commercial fisheries utilize purse seine gear within ¼ mile of San Juan Island and are required to release non-target species (Chinook and coho); (Cunningham 2021).
[62] https://www.sjcmrc.org/projects/southern-resident-killer-whales/
[63] https://www.pacificwhalewatchassociation.com/guidelines/

proposed by NOAA Fisheries as Alternative 4 in the 2009 Environmental Assessment on New Regulations to Protect SRKWs from Vessel Effects in Inland Waters of Washington and represents the area most frequently utilized for foraging and socialization in the San Juan Islands. WDFW will continue to work with San Juan County and will plan to adjust their outreach on a voluntary No-Go zone to be consistent with any outcomes of current marine spatial planning processes.

Figure 17. An approximation of the Voluntary "No-Go" Whale Protection Zone, from Mitchell Bay to Cattle Point (Shaw 2018). See https://wdfw.wa.gov/fishing/locations/marine-areas/san-juan-islands

7) Currently WDFW enforcement boats conduct coordinated patrols with the U.S. Coast Guard, NOAA Office of Law Enforcement, San Juan County Sheriff's Office, Sound Watch, and other partners year-round that include monitoring and enforcement of fisheries and Marine Mammal Protection Act requirements related to vessel operation in the presence of marine mammals throughout Puget Sound. Patrols in the marine areas of northern Puget Sound, particularly MA 7, are specifically targeted to enforce regulations related to killer whales. These patrols will be increased in intensity at times SRKW calves are present. For comparison, in 2017, WDFW Police conducted 55 patrols; in 2018, they conducted 140 patrols; and in 2019 they conducted 105 patrols specific to MA7 during the summer (Cunningham 2021). Outreach and enforcement of vessel regulations will reduce the vessel

effects (as described in Ferrara et al. (2017)) of recreational and commercial whale watching vessels in U.S. waters of the action area.

On March 14, 2018, WA Governor's Executive Order 18-02 was signed and it ordered state agencies to take immediate actions to benefit SRKW and established a Task Force to identify, prioritize, and support the implementation of a longer-term action plan needed for SRKW recovery. The Task Force provided recommendations in a final Year 1 report in November 2018.[64] In 2019, a new state law was signed that increases vessel viewing distances from 200 to 300 yards to the side of the whales and reduces vessel speed within ½ nautical mile of the whales to seven knots over ground. SB 5918 amends RCW 79A.60.630 to require the state's boating safety education program to include information about the Be Whale Wise guidelines, as well as all regulatory measures related to whale watching, which is expected to decrease the effects of vessel activities to whales in state waters.

On November 8, 2019, the task force released its Year 2 report[65] that assessed progress made on implementing Year 1 recommendations, identified outstanding needs and emerging threats, and developed new recommendations. Some of the progress included increased hatchery production to increase prey availability. In response to recommendations of the Washington State Southern Resident Killer Whale Task Force, the Washington State Legislature provided approximately $13 million in funding "prioritized to increase prey abundance for southern resident orcas" (Engrossed Substitute House Bill 1109) for the 2019-2021 biennium (July 2019 through June 2021)

On March 7, 2019 the state passed House Bill 1579 that addresses habitat protection of shorelines and waterways (Chapter 290, Laws of 2019 (2SHB 1579)), and funding was included for salmon habitat restoration programs and to increase technical assistance and enforcement of state water quality, water quantity, and habitat protection laws. Other actions included providing funding to the Washington State Department of Transportation to complete fish barrier corrections. Although these measures won't improve prey availability in 2020/2021, they are designed to improve conditions in the long-term.

Notwithstanding the beneficial effects of ongoing habitat restoration actions, the cumulative effects associated with continued development are reasonably certain to have adverse effects on all the listed species populations addressed in this Opinion. Only improved, low-impact development actions together with increased numbers of restoration actions, watershed planning, and recovery plan implementation would be able to address growth related impacts into the future. To the extent that non-federal recovery actions are implemented and offset ongoing development actions, adverse cumulative effects may be minimized, but will probably not be completely avoided.

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[64] Available at: https://www.governor.wa.gov/sites/default/files/OrcaTaskForce_reportandrecommendations_11.16.18.pdf, last visited May 26, 2019.

[65] Available at: https://www.governor.wa.gov/sites/default/files/OrcaTaskForce_FinalReportandRecommendations_11.07.19.pdf, last visited May 26, 2019.

2.7. Integration and Synthesis

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

2.6.1 Integration for Critical Habitat

At the designation scale, the quality of PS Chinook salmon critical habitat is generally poor with only a small amount of freshwater and nearshore habitat remaining in good condition. Most critical habitat for this species is degraded but nonetheless maintains a high importance for conservation of the species, based largely on its restoration potential. Loss of freshwater and nearshore critical habitat quality is a limiting factor for this species. Development of shoreline and estuary areas of Puget Sound is expected to continue to adversely impact the quality of critical habitat PBFs for PS Chinook salmon.

The quality of PS steelhead critical habitat also varies, with a small amount of habitat remaining in good condition. Unlike PS Chinook salmon, PS steelhead critical habitat is only designated in freshwater rivers and streams. Nearshore marine areas are not designated because juvenile steelhead do not use nearshore areas extensively. Poor quality of freshwater critical habitat quality is a limiting factor for PS steelhead.

Critical habitat for HCSR chum salmon is designated in stream, rivers, and nearshore areas of the Hood Canal basin. Although some critical habitat for this species is degraded, several nearshore areas of critical habitat remain in good condition. Implementation of recovery plan actions for HCSR chum salmon, including development of an in-lieu fee program for projects that impact critical habitat for this species, represent positive steps toward addressing habitat limiting factors for this species.

Critical habitat for PS/GB bocaccio and yelloweye rockfish includes hundreds of square miles of deep-water areas in Puget Sound. Large areas of nearshore habitat are also designated, but only for juvenile bocaccio. Juvenile bocaccio use shallow nearshore areas extensively during life history while yelloweye rockfish do not. The quality of nearshore critical habitat for PS/GB bocaccio has been degraded by nearshore development and in-water construction, dredging and disposal of dredged material, pollution and runoff.

Critical habitat for SRKWs is designated in Puget Sound and certain areas outside Puget Sound. Only area designated within Puget Sound will be affected by the proposed actions. Within Puget Sound, the quality of critical habitat for SRKWs has been negatively affected by degradation of water quality, vessel noise, and a reduction of prey availability. Over the past several years, the reduced and declining SRKW status has become a serious concern. PS Chinook salmon, a key part of the prey PBF for SRKW critical habitat, is a concern for this programmatic consultation.

PS steelhead critical habitat is not designated in nearshore areas and will not be meaningfully affected by direct effects of projects covered under SSNP. Some impacts such a noise created by vessel operation caused by the proposed action will occur in PS steelhead critical habitat. Those impacts are not expected to meaningfully affect the quality of PS steelhead critical habitat. Similarly, critical habitat for yelloweye rockfish is designated only in deep water areas of Puget Sound and will not be directly affected by the projects. As with steelhead critical habitat, some impacts from vessels may affect yelloweye rockfish critical habitat, but those impacts have no meaningful effect on the quality of this species critical habitat. We can therefore conclude that that the SSNP action will not diminish the value of critical habitat for the conservation of the PS steelhead and yelloweye rockfish.

The effects of projects covered under SSNP would primarily impact nearshore areas of the critical habitats for PS Chinook salmon, HCSR chum salmon, and PS/GB bocaccio. For SRKWs, the impact of the proposed action is primarily on the prey PBF. This impact is caused by the loss of nearshore habitat quality that results in a reduction in the abundance of PS Chinook salmon. The remainder of our integration and synthesis for critical habitat will focus on how the effects of the proposed actions, when added to environmental baseline and cumulative effects, impact the ability of PBFs to support conservation of PS Chinook salmon, HCSR chum salmon, PS/GB bocaccio, and SRKWs.

Modification of nearshore habitat in Puget Sound has resulted in a substantial decrease in critical habitat quality for PS Chinook salmon and PS/GB bocaccio. The effect on critical habitat for HCSR chum salmon is similar, but most of the critical habitat for this species remains in good condition. As noted in Section 2.3, shoreline development is the primary cause of this decline in habitat quality. Development includes shoreline armoring, filling of estuaries and tidal wetlands, and construction of overwater structures. Currently, 30 percent of Puget Sound's shorelines are armored (Meyer el al. 2010).

Once developed, shoreline areas tend to remain developed due to the high residential, commercial, and industrial demand for use of these areas. New development continues and as infrastructure deteriorates, it is rebuilt. Shoreline bulkheads, marinas, residential piers, ramps, floats (PRFs), and port facilities are quickly replaced as needed. Although designs of replacement infrastructure are often more environmentally friendly, replacement of these structures ensures their physical presence will cause adverse impacts on nearshore habitat into the future. This is evidenced by the continued requests for consultation on these types of actions. As a result, shoreline development causes a "press disturbance" in which habitat perturbations accumulate without periods of ecosystem recovery. This interrupts the natural cycles of habitat disturbance and recovery crucial for maintenance of critical habitat quality over time. Although the occasional restoration project will improve nearshore habitat quality, the area impacted by these projects is tiny compared to the developed area. The general trend of nearshore habitat quality is downward and is unlikely to change given current management of these areas.

Nearshore habitat modification has caused broad-scale ecological changes, reducing the ability of critical habitat to support PS Chinook salmon juvenile migration and rearing. The loss of submerged aquatic vegetation, including eelgrass and kelp, has reduced cover, an important PBF of critical habitat for PS Chinook salmon. Degradation of sand lance and herring spawning habitat has reduced the quality of the forage PBF. Construction of overwater structures throughout Puget Sound has degraded PS Chinook salmon critical habitat by creating artificial obstructions to free passage in the nearshore marine area. Habitat modification that have occurred in Puget Sound to date have reduced juvenile survival and in some cases, eliminated PS Chinook salmon life history strategies that rely on rearing in nearshore areas during early life history.

Changes to nearshore areas in Puget Sound have also reduced the ability of critical habitat to support juvenile life stages of PS/GB bocaccio. Loss of submerged aquatic vegetation has reduced cover available for larval and juvenile rockfish. Changes in physical character of nearshore areas and loss of water quality reduce the amount of prey available for juvenile rockfish. Although loss of nearshore habitat quality is a threat to bocaccio, the recovery plan for this species lists the severity of this threat as low (NMFS 2017a). Other factors, such as overfishing, are more significant threats to PS/GB bocaccio.

Given the rate of expected population growth in the Puget Sound area, cumulative effects are expected to result in mostly negative impacts on critical habitat quality. While habitat restoration and advances in best management practices for activities that affect critical habitat could lead to some improvement of PBFs, adverse impacts created by the intense demand for future development is likely to outpace any improvements. Current state and local regulations do not prevent much of the development that degrades the quality of nearshore critical habitats. There is no indication these regulations are reasonably certain to change in the foreseeable future

The programmatic action for SSNP is a mix of activity types with some positive as well as number of adverse effects on the quality of Puget Sound nearshore habitat critical habitat for PS Chinook salmon, bocaccio, and SRKWs including:

- Removal of creosote treated piles and bulkheads would improve water quality by removing these chronic sources of contaminants (Table 21).
- Planting, rubble removal, and beach nourishment will improve habitat.
- Replacement of impervious surface or stormwater facilities created discharge of stormwater. This can degrade water quality, but in many cases, areas with currently untreated stormwater would receive treatment under the SSNP action.
- Conversion of solid wood decking to grated decking on replacement structures would reduce the amount of shade under overwater structures, compared to current conditions.
- In the short-term, the proposed construction activities can kill, injure, or disturb normal behavior patterns of fish close to the project site.
- Construction of new or replacement residential and commercial overwater structures would create shade, suppress submerged aquatic vegetation, interrupt migration of juvenile PS Chinook salmon, and provide cover for predatory fish that eat juvenile salmon.

- Replacement or construction of new shoreline armoring would prevent development of shoreline vegetation, and impede sediment and organic material supply to beaches.
- In some locations, replacement of shoreline armoring would cause beach erosion waterward of the armoring, which, in turn, would lower beaches, coarsen substrate, increase sediment temperature, and reduce invertebrate density.
- Replacement of shoreline armoring would prevent development of suitable habitat for forage fish spawning and likely reduce abundance and productivity of these important salmon prey items.
- Replacement of vessel-related overwater structures would ensure current or greater levels of vessel use in Puget Sound.
- Replacement of utilities would primarily result in short-term construction effects.
- Dredging would removes benthic substrate and reduce forage PBF for juvenile salmonids and rockfish. Dredging will convert a small amount of shallow nearshore habitat to deep-water habitat, reducing its quality for listed species.

The design of the SSNP action is a critical factor in our assessment. The activity types and associated design criteria were carefully selected to ensure that environmental outcomes of each activity can be readily predicted. As described in the analysis of the effects of the action (Section 2.4), the effects of the proposed activities primarily cause short-term, localized, and minor effects. These effects are mostly caused by in- and near-water construction and last, at most, a year or two. General construction measures required by the SSNP ensure minimization of short-term effects and recovery of function of aquatic and riparian habitat at disturbed sites.

The location of projects covered under SSNP will be spread across the Salish Sea. Although there is some geographic clumping of projects around urban areas, the geographic extent of short-term adverse effects from projects do not typically overlap. The short-term adverse effects of projects will bear on far too small of an area to meaningfully affect the conservation value of critical habitat for PS Chinook salmon, bocaccio, and SRKW.

Activities involving replacement of existing structures will often result in a reduction of current impacts and improved habitat quality at project sites because SSNP require fish-friendly designs of replacement structures. For instance, replacement of undersized bridges and culverts with appropriately sized and designed structures improves fish passage and reduces impacts on floodplain function. Replacement of overwater structures made of treated wood piles and decking with steel piles and grated decking will reduce shade and decrease input of contaminants into surrounding water. Conversion of rock or concrete bulkheads to a hybrid approach using living shoreline concepts will reduce impacts on shoreline habitat forming processes. Most importantly, all enduring or long-term effects of structures on nearshore habitat quality must be compensated through conservation offsets. By including this requirement in SSNP, we expected no-net loss of nearshore habitat or critical habitat conservation value over time.

The types of new structures authorized under SSNP include only those that lend themselves to a programmatic analysis. New marine terminals and large-scale commercial or industrial structures are beyond the scope of analysis in SSNP. Under SSNP design criteria new structures require fish-friendly features such as grated decking and use of treated wood piles only when methods are applied to minimize the wood preservative reaching the water. All impacts of new structures on nearshore habitat must be compensated through conservation offsets.

Standalone habitat enhancement activities (those not carried out to achieve conservation offsets) will result in long-term beneficial effects on quality of critical habitat. The number of habitat restoration actions varies year to year based on available funding for restoration and other social and economic factors. Although we cannot predict the exact level of habitat improvement resulting from restoration projects, we can be certain of at least some level of improvement throughout the Salish Sea. Passage of the Infrastructure Investment and Jobs Act has made millions of dollars available for habitat restoration and improvements to fish passage at road-stream crossings. We expect that over the next several years, many projects funded through this Act will be authorized under SSNP.

As discussed above, some activity types, such as the installation of new over-water structures or replacement of overwater structures and bulkheads result in an enduring loss of nearshore habitat quality. In addition to design criteria that minimize the effects of these activities, conservation offsets are required to compensate for the permanent loss of habitat quality. Some restoration activities covered by SSNP will be carried out to achieve conservation offsets. Actions offered for conservation offsets would include pile removal, riparian planting, removal of shoreline armoring, derelict vessel removal, or removal of over-water structures. Available information, including NMFS' experience with the reasonable and prudent alternatives, requiring conservation offsets, from three batched jeopardy opinions on projects in the Salish Sea nearshore, shows these actions are effective in compensating for the loss of critical habitat quality. Conservation offsets may also be acquired through purchase of conservation bank credits or contributions to in-lieu fee programs.

The conservation offsets in the nearshore required by SSNP are expected to achieve a no-net-loss of habitat function in the Puget Sound nearshore, which is needed to help ensure that PS Chinook salmon do not continue to drop below the existing juvenile survival rates (Kilduff et al. 2014, Campbell et al. 2017) and in turn will not further reduce available SRKW prey. As detailed above, PS Chinook salmon juvenile survival is directly linked to the quality and quantity of nearshore habitat. Campbell et al. 2016 has most recently added to the evidence and correlation of higher juvenile survival in areas where there is a greater abundance and quality of intact and restored estuary and nearshore habitat. Relatedly, there is emerging evidence that without sufficient estuary and nearshore habitat, significant life history traits within major population groups are being lost. And specific to this action area, there appear to be higher rates of mortality in the fry life stage in the more urbanized watersheds. By contrast, in watersheds where the estuaries are at least 50 percent functioning, fry out-migrants made up at least 30 percent of the returning adults, compared to the 3 percent in watersheds like the Puyallup and the Green Rivers, where 95 percent of the estuary has been lost. This also means that for projects that occur in less developed areas and within stretches of functioning habitats, no net loss is even more crucial. It has been long understood that protection and conservation of existing unimpaired systems is more effective and efficient than full restoration of impaired systems (Cereghino et al. 2012, Goetz et al. 2004, Greiner 2010). Here, required conservation offsets will not result in adding to the needed nearshore restoration, but they will ensure that the proposed programmatic action does not cause nearshore habitat conditions and critical habitat quality to get worse.

We expect conservation offsets implemented under the SSNP proposed action to be in place within one to several years of Corps permit issuance, and expect that the offsetting effects of the restoration would begin to occur as soon as one year of restoration project completion. This expected time delay in achieving a conservation offset is acceptable because significant evidence supports our assumption that ecosystem improvements restoration in nearshore environments will occur rapidly once restoration is complete. For example, Lee et al. (2018) documented strong and positive biotic restoration response within one year of the removal of shoreline armoring. In addition, following significant estuary restoration in the Nisqually River delta, salmon catch data indicated that smolts were using this newly accessible habitat as early as one year post-restoration (Ellings 2016).

Additionally, there have been recent increases in production at conservation hatcheries and agreements to reduce harvest levels that are aimed at stemming the near-term population decline of Chinook salmon and help ensure an immediate prey supply for SRKW. The conservation hatchery efforts for PS Chinook salmon and reduced harvest levels will continue to help maintain current population levels of Chinook salmon and SRKW while conservation offsets are implemented and conservation benefits on critical habitat are realized.

In summary, most projects carried out under SSNP will have short-term adverse effects on critical habitat resulting from construction activities. As stated earlier, these short-term adverse effects will impact far too small of an area to cause any meaningful loss of critical habitat quality. Moreover, most of these short-term effects ameliorate over time and habitat will recover, Restoration projects will result in a long-term improvement of critical habitat quality. Projects involving replacement of structures typically result in a reduction of current impacts and a net improvement in habitat quality. Some activities result in an enduring loss of critical habitat quality. However, these activities require conservation offsets to compensate for the loss of critical habitat quality. On balance, we expect no-net loss of critical habitat quality will result implementation of the SSNP action. Thus, the proposed program is not likely to result in appreciable reduction in the value of designated critical habitat for the conservation of the species addressed in this biological opinion.

2.6.2 Integration for Species

PS Chinook salmon are currently listed as threatened with generally negative recent trends in status. Widespread negative trends in natural-origin spawner abundance across the ESU have been observed since 1980. Productivity remains low in most populations, and hatchery-origin spawners are present in high fractions in most populations outside of the Skagit watershed. Most populations are consistently below the spawner-recruit levels identified by the recovery plan for this ESU. Development of shoreline and estuary areas of Puget Sound is expected to continue to adversely impact the quality of marine habitat for PS Chinook salmon.

HCSR chum salmon have made substantive gains towards meeting this species' recovery plan viability criteria. The most recent 5-year review for this ESU notes improvements in abundance and productivity for both populations that make up this ESU. However, the ESU still does not meet all of the recovery criteria for population viability at this time. Implementation of recovery plan actions for HCSR chum salmon, including development of an in-lieu fee program for projects that impact critical habitat for this species, represent positive steps toward addressing habitat limiting factors for this species.

The most recent 5-year review for PS steelhead notes some signs of modest improvement in productivity since the previous review, at least for some populations, especially in the Hood Canal and Strait of Juan de Fuca MPG. However, these modest changes must be sustained for a longer period (at least two generations) to lend sufficient confidence to any conclusion that productivity is improving over larger scales across the DPS. Moreover, several populations are still showing dismal productivity, especially those in the Central and South Puget Sound MPG (NWFSC 2015). Trends in abundance of natural spawners remain predominantly negative. Particular aspects of diversity and spatial structure, including natural spawning by hatchery fish and limited use of suitable habitat, are still likely to be limiting viability of most PS steelhead populations. In the near term, the outlook for conditions affecting PS steelhead is not optimistic. While harvest and hatchery production of steelhead in Puget Sound are currently at low levels and are not likely to increase substantially in the foreseeable future, some recent environmental trends not favorable to PS steelhead survival and production are expected to continue.

SRKWs are at risk of extinction in the foreseeable future. NMFS considers SRKWs to be currently among nine of the most at-risk species as part of the Species in the Spotlight initiative because of their endangered status, declining population trend, and they are high priority for recovery based on conflict with human activities and recovery programs in place to address threats. The population has relatively high mortality and low reproduction unlike other resident killer whale populations that have generally been increasing since the 1970s (Carretta et al. 2021). Reduced prey availability is a major limiting factor for this species.

PS/GB bocaccio are listed as endangered and abundance of this species likely remains low. PS/GB yelloweye rockfish are listed as threatened but likely persist at abundance levels somewhat higher than bocaccio. Lack of specific information on rockfish abundance in Puget Sound makes it difficult to generate accurate abundance estimates and productivity trends for these two DPSs. Available data does suggest that total rockfish declined at a rate of 3.1 to 3.8 percent per year from 1977 to 2014 or a 69 to 76 percent total decline over that period. The two listed DPSs declined over-proportional compared to the total rockfish assemblage.

PS steelhead complete much of their early life history in freshwater and do not rely on nearshore areas of Puget Sound for rearing as Chinook and chum salmon do. Since the projects authorized under SSNP would primarily affect the quality of nearshore habitat, PS steelhead are spared from many of the adverse effects. Short-term construction- related impacts such as elevated noise and turbidity would likely injure or kill a small number of PS steelhead but not enough to result in any population-level effects. Considering both short-term and potential long-term impacts, the proposed actions would not have any meaningful effects on PS steelhead population abundance, productivity, spatial structure, or diversity.

Juvenile yelloweye rockfish are not typically found in nearshore habitat and adults are found solely in deep water areas of Puget Sound. Larval yelloweye rockfish are found in nearshore areas and would likely be exposed to the short-term effects of the proposed construction. However, the projects authorized under SSNP would only result in short-term impacts to larval rockfish. Given the low overall level of impact, the proposed action will not have any meaningful effect on the numbers, reproduction, or distribution of yelloweye rockfish.

The effects of the proposed actions would primarily impact nearshore areas of Puget Sound. This reduces survival of early life-stages of PS Chinook salmon, HCSR chum salmon, and PS/GB bocaccio. For SRKWs, the impact of the proposed action is primarily on their primary prey, Chinook salmon. The remainder of the integration and synthesis for our jeopardy determination will focus on how the effects of the proposed actions, when added to environmental baseline and cumulative effects, affect the likelihood of both the survival and recovery of PS Chinook salmon, HCSR chum salmon, PS/GB bocaccio, and SRKWs.

Modification of nearshore habitat in Puget Sound has resulted in a substantial decrease in habitat quality for PS Chinook salmon. This has coincided in decreased survival at early life history stages and lower population abundance and productivity (Magnusson and Hilborn 2003, Meador 2013). The effect on nearshore habitat used by HCSR chum salmon is similar, but most of the available habitat for this species remains in good condition. For PS/GB bocaccio, degradation of nearshore habitat quality has likely reduced juvenile survival. However, this is not considered to be a primary threat to this species.

As noted in Section 2.3, shoreline development is the primary cause of this decline in nearshore habitat quality. Development includes shoreline armoring, filling of estuaries and tidal wetlands, and construction of overwater structures.

As explained earlier, once developed, shoreline areas tend to remain developed due to high residential, commercial, and industrial demand for use of these areas. New development continues and as infrastructure deteriorates, it is rebuilt. Shoreline bulkheads, marinas, residential PRFs, and port facilities are quickly replaced as needed. Although designs of replacement infrastructure are often more environmentally friendly, replacement of these structures ensures their physical presence will cause adverse effects on nearshore habitat into the future. This is evidenced by the continued requests for consultation on these types of actions. As a result, shoreline development causes a “press disturbance” in which habitat perturbations accumulate without periods of ecosystem recovery. This interrupts the natural cycles of habitat disturbance and recovery crucial for maintenance of habitat quality over time. Although restoration projects improve nearshore habitat quality, the area impacted by these projects is tiny compared to the developed area. The general trend of nearshore habitat quality is downward and is unlikely to change given current management of these areas.

Nearshore habitat modification has caused broad-scale ecological changes, reducing the ability of critical habitat to support PS Chinook salmon juvenile migration and rearing. The loss of submerged aquatic vegetation, including eelgrass and kelp, has reduced cover, an important feature of habitat for PS Chinook salmon. Degradation of sand lance and herring spawning habitat has reduced the quantity of the forage for PS Chinook salmon. Construction of overwater structures throughout Puget Sound has degraded PS Chinook salmon habitat by creating artificial obstructions to free passage in the nearshore marine area. Habitat modification that have occurred in Puget Sound to date have reduced juvenile survival and in some cases, have eliminated PS Chinook salmon life history strategies that rely on rearing in nearshore areas during early life history.

Given the rate of expected population growth in the Puget Sound area, cumulative effects are expected to result in mostly negative impacts on critical habitat quality. While habitat restoration and advances in best management practices for activities that affect critical habitat could lead to some improvement of PBFs, adverse impacts created by the intense demand for future development is likely to outpace any improvements. Current state and local regulations do not prevent much of the development that degrades the quality of nearshore critical habitats. There is no indication these regulations are reasonably certain to change in the foreseeable future.

The programmatic action for SSNP is a mix of activity types with some positive as well as number of adverse effects on the quality of Puget Sound nearshore habitat critical habitat for PS Chinook salmon, bocaccio, and SRKWs including:

- Removal of creosote treated piles and bulkheads would improve water quality by removing these chronic sources of contaminants.
- Planting, rubble removal, and beach nourishment will improve habitat.
- Replacement of impervious surface or stormwater facilities created discharge of stormwater. This can degrade water quality, but in many cases, areas with currently untreated stormwater would receive treatment under the SSNP action.
- Conversion of solid wood decking to grated decking on replacement structures would reduce the amount of shade under overwater structures, compared to current conditions.
- In the short-term, the proposed construction activities can kill, injure, or disturb normal behavior patterns of fish close to the project site.
- Construction of new or replacement residential and commercial overwater structures would create shade, suppress submerged aquatic vegetation, interrupt migration of juvenile PS Chinook salmon, and provide cover for predatory fish that eat juvenile salmon.
- Replacement or construction of new shoreline armoring would prevent development of shoreline vegetation, and impede sediment and organic material supply to beaches.
- In some locations, replacement of shoreline armoring would cause beach erosion waterward of the armoring, which, in turn, would lower beaches, coarsen substrate, increase sediment temperature, and reduce invertebrate density.
- Replacement of shoreline armoring would prevent development of suitable habitat for forage fish spawning and likely reduce abundance and productivity of these important salmon prey items.
- Replacement of vessel-related overwater structures would ensure current or greater levels of vessel use in Puget Sound.
- Replacement of utilities would primarily result in short-term construction effects.
- Dredging would remove benthic substrate and reduce forage for juvenile salmonids and rockfish. Dredging will convert a small amount of shallow nearshore habitat to deep-water habitat, reducing its quality for listed species.

As explained in the previous section, the design of the SSNP action is a critical factor in our assessment. The activity types and associated design criteria were carefully selected to ensure that environmental outcomes of each activity can be readily predicted. As described in the analysis of the effects of the action (Section 2.4), the effects of the proposed activities primarily cause short-term, localized, and minor effects. These effects are mostly caused by in- and near-water construction and last, at most, a year or two. General construction measures required by the SSNP ensure minimization of short-term effects and recovery of function of aquatic and riparian habitat at disturbed sites.

The location of projects covered under SSNP will be spread across the Salish Sea. Although there is some geographic clumping of projects around urban areas, the geographic extent of short-term adverse effects from projects do not typically overlap. The short-term adverse effects of projects will bear on far too small a number of individuals to meaningfully affect the population viability criteria for PS Chinook salmon, bocaccio, and SRKW.

Activities involving replacement of existing structures will often result in a reduction of current impacts and improved habitat quality at project sites because SSNP require fish-friendly designs of replacement structures. For instance, replacement of undersized bridges and culverts with appropriately sized and designed structures improves fish passage and reduces impacts on floodplain function. Replacement of overwater structures made of treated wood piles and decking with steel piles and grated decking will reduce shade and decrease input of contaminants into surrounding water. Conversion of rock or concrete bulkheads to a hybrid approach using living shoreline concepts will reduce impacts on shoreline habitat forming processes. Most importantly, all enduring or long-term effects of structures on nearshore habitat quality must be compensated through conservation offsets. By including this requirement in SSNP, we expected no net loss of nearshore habitat over time.

The types of new structures authorized under SSNP include only those that lend themselves to a programmatic analysis. New marine terminals and large-scale commercial or industrial structures are beyond the scope of analysis in SSNP. Under SSNP, design criteria for new structures require fish-friendly features such as grated decking and use of treated wood piles only when methods are applied to minimize the wood preservative reaching the water. All impacts of new structures on nearshore habitat must be compensated through conservation offsets.

Habitat enhancement activities will result in long-term beneficial effects on habitat quality of critical habitat. The number of habitat restoration actions varies year to year based on available funding for restoration and other social and economic factors. Although we cannot predict the exact level of habitat improvement resulting from restoration projects, we can be certain of at least some level of improvement throughout the Salish Sea. Passage of the Infrastructure Investment and Jobs Act has made millions of dollars available for habitat restoration and improvements to fish passage at road-stream crossings. We expect that over the next several years, many projects funded through this Act will be authorized under SSNP. Some restoration activities will be carried out to achieve conservation offsets.

As discussed above, some activity types, such as the installation of new over-water structures or replacement of overwater structures and bulkheads result in an enduring loss of nearshore habitat quality. In addition to design criteria that minimize the effects of these activities, conservation offsets are required to compensate for the permanent loss of habitat quality. Actions carried out to achieve conservation offsets would include pile removal, riparian planting, removal of shoreline armoring, derelict vessel removal, or removal of over-water structures. Available information shows these actions are effective in compensating nearshore habitat quality. Conservation offsets may also be acquired through purchase of conservation bank credits or contributions to in-lieu fee programs.

The conservation offsets in the nearshore required by SSNP are expected to achieve a no-net-loss of nearshore habitat function in the Puget Sound, which is needed to help ensure that PS Chinook salmon do not continue to drop below the existing juvenile survival rates (Kilduff et al. 2014, Campbell et al. 2017) and in turn will not further reduce available SRKW prey. As detailed above, PS Chinook salmon juvenile survival is directly linked to the quality and quantity of nearshore habitat. Campbell et al. 2016 has most recently added to the evidence and correlation of higher juvenile survival in areas where there is a greater abundance and quality of intact and restored estuary and nearshore habitat. Relatedly, there is emerging evidence that without sufficient estuary and nearshore habitat, significant life history traits within major population groups are being lost. And specific to this action area, there appear to be higher rates of mortality in the fry life stage in the more urbanized watersheds. By contrast, in watersheds where the estuaries are at least 50 percent functioning, fry out-migrants made up at least 30 percent of the returning adults, compared to the 3 percent in watersheds like the Puyallup and the Green Rivers, where 95 percent of the estuary has been lost. This also means that for projects that occur in less developed areas and within stretches of functioning habitats, no net loss is even more crucial. It has been long understood that protection and conservation of existing unimpaired systems is more effective and efficient than full restoration of impaired systems (Cereghino et al. 2012, Goetz et al. 2004, Greiner 2010). Here, required conservation offsets will not result in adding to the needed nearshore restoration, but they will ensure that the proposed programmatic action does not cause nearshore habitat conditions to get worse.

We expect conservation offsets implemented under the SSNP proposed action to be in place within one to several years of Corps permit issuance, and expect that the offsetting effects of the restoration would begin to occur as soon as one year of restoration project completion. This expected time delay in achieving a conservation offset is acceptable because significant evidence supports our assumption that ecosystem improvements restoration in nearshore environments will occur rapidly once restoration is complete. For example, Lee et al. (2018) documented strong and positive biotic restoration response within one year of the removal of shoreline armoring. In addition, following significant estuary restoration in the Nisqually River delta, salmon catch data indicated that smolts were using this newly accessible habitat as early as one year post-restoration (Ellings 2016).

Additionally, there have been recent increases in production at conservation hatcheries and agreements to reduce harvest levels that are aimed at stemming the near-term population decline of Chinook salmon and help ensure an immediate prey supply for SRKW. The conservation hatchery efforts for PS Chinook salmon and reduced harvest levels will continue to help maintain current population levels of Chinook salmon and SRKW while conservation offsets are implemented and conservation benefits are realized.

In summary, most projects carried out under SSNP will have short-term adverse effects on habitat resulting from construction activities. As stated earlier, these short-term adverse effects will impact far too individuals to cause any meaningful on population viability for any affected species. Moreover, most of these short-term effects ameliorate over time and habitat will recover. Restoration projects will result in a long-term improvement of habitat quality. Projects involving structures typically result in a reduction of current impacts and a net improvement in habitat quality. Some activities result in an enduring loss of habitat quality. However, these activities require conservation offsets to compensate for the loss of nearshore habitat quality. In the long-term, a no-net loss approach to nearshore habitat quality will avoid negative effects on population viability especially for PS Chinook salmon. Even with the expected negative effects of climate change, the SSNP action will not appreciably reduce the likelihood of survival and recovery of any the listed species addressed but this biological opinion.

2.8. Conclusion

After reviewing the current status of the listed species, the environmental baseline within the action area, the effects of the SSNP proposed action, and cumulative effects, it is NMFS's biological opinion that the proposed action is not likely to jeopardize the continued existence of PS Chinook salmon, SRKW, PS/GB yelloweye rockfish, PS/GB bocaccio rockfish, HCSR chum salmon, and PS steelhead or result in the destruction or adverse modification of critical habitat that has been designated for these species.

2.9. Incidental Take Statement

Section 9 of the ESA and federal regulations pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without a special exemption. "Take" is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. "Harm" is further defined by regulation to include significant habitat modification or degradation that actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including breeding, spawning, rearing, migrating, feeding, or sheltering (50 CFR 222.102). "Harass" is further defined by interim guidance as to "create the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding, or sheltering." "Incidental take" is defined by regulation as takings that result from, but are not the purpose of, carrying out an otherwise lawful activity conducted by the Federal agency or permittee (50 CFR 402.02). Section 7(b)(4) and section 7(o)(2) provide that taking that is incidental to an otherwise lawful agency action is not considered to be prohibited taking under the ESA if that action is performed in compliance with the terms and conditions of this ITS.

2.9.1 Amount or Extent of Take

Projects authorized under SSNP will take place beside and within aquatic habitats that are reasonably certain to be occupied by individuals of the ESA-listed species considered in this opinion. As explained in 1.2.1, we considered information from the Corps' consultation request, information from completed consultations, and information from consultation requests to project the future level of activity expected under SSNP. In developing indicators or surrogates to express the extent of incidental take, the values of the metrics used to project levels of activity were round up or down to a relevant whole number (e.g., 23,699 linear was rounded to 24,000 linear feet). As described below, the proposed action is reasonably certain to cause incidental take of one or more of those species.

We expect that the amount or extent of take described below is for a typical year of work that would be authorized under SSNP. This amount and extent of take is not expected to be account for any take caused by the projects currently in the list of pending consultations. NMFS currently has approximately 100 pending consultations[66] in the nearshore of the Salish Sea that could potentially be authorized under SSNP. NMFS and the Corps will endeavor to complete these consultations as expeditiously as possible, but anticipate that it could take up to two years to fully clear all pending consultations that may qualify for coverage under SSNP. As a result, and taking a conservative approach to planning, we anticipate that during the first two years of activity the expected take will be approximately double what is expressed in Table 3 to account for the existing consultations in addition to new projects anticipated to be authorized under SSNP. Since many projects have been delayed due to the amount of existing consultations, the level of impact on nearshore habitat over the past two years (2020 and 2021) has been low. Up to the first two years following the finalization of SSNP will represent a "catch-up" period when pending consultations and new projects are authorized. Essentially, the work authorized under SSNP for up to the first two years will represent four years' worth of work. The amount or extent of incidental take, identified below in Table 18 includes estimates for typical future years as well as up to the two years directly following SSNP finalization. It is possible that the pending consultations will be cleared much more quickly than two years, in which case that expected amount of two-years' worth of take may occur sooner.

Harassment, capture, death, injury of juvenile fish at in-water work area construction sites

Juvenile salmon, steelhead, and rockfish would be harassed, injured, captured or killed at in-water construction sites due to dewatering, fish salvage efforts, increased turbidity, decreased dissolved oxygen. Exclusion from preferred habitat areas causes increased energy use and an increased likelihood of predation, competition and disease that is reasonably certain to result in injury or death of some individual fish.

Based on fish salvage efforts carried out under similar programmatic consultations, NMFS anticipates that up to 10, 000 juvenile salmon, steelhead, and rockfish will be captured annually during fish salvage associated with work area isolation (Table 18). Less than 5% of these fish are expected to die during the single-event salvage process.

Entrainment, increased turbidity, and resuspension of contaminants from dredging.

Salmon, steelhead, and rockfish will be entrained, injured, or killed during dredging operations with a suction dredge. The use of a clamshell or bucket to dredge is less likely to entrain juveniles. Most fish that are entrained will be injured or killed. The exact number of juveniles that would be entrained cannot be determined due to extensive variables. The best available indicator of take is one that best describes the dredging efforts relative to the amount of materials dredged. Fish will also be injured or killed by increased turbidity and resuspension of

[66] As used here, this term refers to any consultation request yet to be completed as of May 1st, 2022

contaminants. The extent of take for incidental take caused by dredging is the maximum volume of material dredged annually. This indicator is appropriate for this proposed action because it is directly related to the magnitude of incidental take caused by dredging. As explained earlier, to determine the maximum volume amounts of materials dredged, we reviewed implementation records from other programmatic consultation as well as consultation requests received during 2021. Based on this review, we expect the total amount of material dredged for vessel access to not exceed 34,000 cubic yards annually. There was less information available for dredging to maintain water intake structures, culverts, or outfalls. Based on our experience with other programmatic consultations, we expect this activity would result in no more than 500 cubic yards of material dredged annually (Table 18).

Pile driving

Installation or removal of piles will cause underwater sound sufficient to harass, injure, or kill salmon, steelhead, and rockfish. The implementation of marine mammal monitoring pans with stop work provisions will ensure not incidental take of SRKWs from pile driving or removal. NMFS cannot estimate the number of fish harassed, injured, or killed by pile driving or removal because fish presence at project sites will vary depending on time of years, water temperature, forage distribution and many other factors. Additionally, there are limited ways to count or observe the number of fish exposed to the adverse effects of pile driving without causing additional risk of injury or harassment. The number of piles driven annually for projects authorized under SSNP is the valid indicator of the amount of incidental take caused by pile driving. The number of piles driven is proportional to the amount of take because each pile driven creates sound that could harass, injure, or kill fish. The risk and total number of fish likely to be exposed as more piles are driven. As explain earlier, the project number of piles expected to be driven annually for project authorized under SSNP is 1,400 (Table 17).

Harm caused by shoreline modification

Shoreline armoring restricts natural beach forming processes (natural erosive processes) by disrupting the supply and replenishment of sediment sources that are the base of forage fish spawning habitat (effects described in Section 2.4, above). As forage fish reproduction is restricted or reduced, so is the availability of food for listed fish (salmon and bocaccio), limiting and reducing the numbers of listed fish that the action area can support. In turn, this limits the number of juvenile PS Chinook salmon that will survive and return to the Puget Sound as adults that supply prey for SRKW. This effect on forage levels is a form of harm in that this loss actually kills or injures PS Chinook salmon and SRKWs by significantly impairing the essential behavioral of feeding. The loss of natural sediment deposition along the shoreline north and south of a structure that supports forage fish and other intertidal and nearshore habitat function are directly proportional to the, length of shoreline armoring and bulkheads. As the length of a bulkhead increases so does impact to sediment inputs. Based on our review of implementation records from other programmatic consultation as well as consultation requests received during 2021, we expect no more than 24,000 feet of shoreline armoring to be repaired, replaced, or constructed (new) annually (Table 18).

Stormwater management

Stormwater runoff from new and repaired/replaced contributing impervious surface would result in delivering a wide variety of pollutants to aquatic ecosystems, such as nutrients, metals, petroleum-related compounds, sediment washed off the road surface, and agricultural chemicals. Stormwater inputs will result in short-term reduction of water quality and an increase in water quantity due to concentrated flows derived from impervious surfaces which are reasonably certain to cause injury to fish depending on the level of exposure. Stormwater contaminants cause a variety of lethal and sublethal effects on fish, including disrupted behavior, reduced olfactory function, immune suppression, reduced growth, disrupted smoltification, hormone disruption, disrupted reproduction, cellular damage, and physical and developmental abnormalities (Fresh et al. 2005; Hecht et al. 2007; Lower Columbia River Estuary Partnership 2007). Stormwater treatment practices and flow control best management practices described in the proposed action will reduce pollution, or other adverse effects of stormwater from occurring up to the design storm level.

This take cannot be accurately quantified as a number of individuals of ESA-listed species because, although the relationship between numerical concentrations of stormwater pollutants are easily demonstrated in the lab, the pollutants in actual runoff come from many small sources that cannot be distinguished after they reach a given waterbody. The distribution of those pollutants also vary widely within that waterbody as a function of surrounding land use, pre-rainfall conditions, rainfall intensity and duration, and mixing from other drainage areas. Stormwater runoff events are often relatively brief, especially in urban streams, so that large inputs of runoff and pollutants can occur and dissipate within a few hours. Moreover, the distribution and abundance of fish that occur within the action area is inconsistent over time, affected by habitat quality, interactions with other species, harvest programs and other influences that cannot be precisely determined by observation or modelling. The best available take indicator reflects the stormwater management requirements and practices that we assumed in analyzing the stormwater effects of the proposed action. The extent of take surrogate for stormwater effects is as follows:

All applicants completing a project to be authorized under this programmatic consultation, that requires post-construction stormwater management, shall complete a post-construction stormwater management plan and receive review and verification from NMFS that the stormwater management plan is adequate in meeting the design criteria found in the SSNP proposed action.

Submission of a stormwater management plan with review and verification by NMFS will not provide a specific measurement of watershed health. However, compliance with the plan development and review requirements reflects the extent of take because they correlate with the level of stormwater treatment that was assumed in the Opinion; any non-compliance with the stormwater plan requirements will result in take at levels that was not analyzed in the Opinion. Although the surrogate is somewhat coextensive with the proposed action it nevertheless functions as a meaningful reinitiation trigger because the permittees can track them and it will be clear if and when these indicators are exceeded.

If the permittee fails to receive NMFS review and verification of a submitted stormwater management plan before the Corps authorizes a particular project, the extent of take will be exceeded and reinitiation provisions of this opinion will be triggered.

Construction and dredging related disturbance (suspended sediment/turbidity).

The best available indicator for the extent of take caused due to temporary water quality impacts of construction and dredging is an increase in visible suspended sediment in the water column. This variable is proportional to the water quality impairment construction and dredging will cause, including increased sediment, temperature, and contaminants, and reduced dissolved oxygen. NMFS assumes that an increase in turbidity will be visible in the immediate vicinity of project areas and for a distance downstream or downcurrent, and the distance that increased sediment will be visible is proportional both to the size of the disturbance and therefore the amount of take that will occur. Also, a turbidity flux may be greater at project sites that are subject to tidal or coastal scour. The extent of take will be exceeded if the turbidity plume generated by construction activities is visible above background levels, above a 10 percent increase in natural turbidity

<u>For non-dredging activities</u>
The levels of suspended sediments and contaminants are expected to be proportional to the amount of injury that the proposed action is likely to cause through physiological stress from elevated suspended sediments and contaminants throughout the duration of the projects' in-water activities. In estuaries, state water quality regulations (WAC173-201A-400) establish a mixing zone of 200 feet plus the depth of water over the discharge port(s) as measured during mean lower low water. As such, NMFS expects that for projects with sediment disturbing activities, that elevated levels of suspended sediment and re-suspended contaminants resulting from construction actions will reach background levels within a 200-foot buffer from the point of suspended sediment generation. Listed fish and their prey resources can be harmed from a wide range of elevated sediment levels and expect that at the point where sediment levels return to background levels that the harm will cease. Thus, the maximum extent of take caused by turbidity levels shall not exceed 5 nephelometric turbidity units (NTUs) more than background turbidity when the background turbidity is 50 NTUs or less, or there shall not be more than a 10 percent increase in turbidity when the background turbidity is more than 50 NTUs.

<u>For dredging activities</u>
The levels and amounts of suspended sediments and contaminants are expected to be proportional to the amount of injury that the proposed action is likely to cause through physiological stress from elevated suspended sediments. For dredging activities that occur in estuary environments, Washington state water quality regulations (WAC173-201A-400) establish mixing zones not to extend to a downstream direction for a distance from the discharge port(s) greater than three hundred feet plus the depth of water over the discharge port(s), or extend upstream for a distance of over one hundred feet. As such, NMFS expects that for projects with dredging, that elevated levels of suspended sediment and re-suspended contaminants resulting from dredging actions will reach background levels within a 300-foot buffer from the point of suspended sediment generation. Listed fish and their prey resources can be harmed from a wide range of elevated sediment levels and expect that at the point where

sediment levels return to background levels that the harm will cease. Thus, the maximum extent of take for turbidity levels caused by dredging shall not exceed 5 nephelometric turbidity units (NTUs) more than background turbidity when the background turbidity is 50 NTUs or less, or there shall not be more than a 10 percent increase in turbidity when the background turbidity is more than 50 NTUs.

Harm due to the presence of in-water and over-water structures and vessel impacts

The physical size (square feet) of an in- or over-water structure is the best available surrogate for the extent of take from exposure to the structure itself and also the accompanying impacts caused by vessels accommodated by the structure. This is because the likelihood of avoidance and the distance required to swim around the structure (migration delay) would both increase as the size of a structure and the intensity of its shadow increase, which would increase the number of juveniles that enter deeper water where forage efficiency would be reduced and vulnerability to predators would be increased. The amount of overwater structure directly determines the amount of shaded area, migration obstruction, reduced benthic productivity and submerged aquatic vegetation (SAV) distrusting and limiting feeding opportunities available at the project sites (effects further described in Section 2.4). The extent of these impacts would increase and decrease depending directly on structure size.

Also, as the size of a structure increases, the number of individual vessels that could moor there generally increases; mooring buoys only allow for one vessel to moor at a time and structure and slip sizes within marinas would dictate the number of individual vessels that could use these facilities. As the number of mooring buoys increases the number of vessels using it will be expected to increase. As size and slip number increase, the number of vessels using a marina could also increase. As the number of vessels increase, boating activity would likely increase, and the potential for ESA-listed species to be exposed to the related noise effects (as described in Sections 2.3, 2.4.1 and 2.4.2) also increases. Based on our review of implementation records from other programmatic consultation as well as consultation requests received during 2021, we expect no more than 220,000 square feet to be repaired, replaced, or constructed (new) annually (Table 18).

Harm caused by resuspension of contaminants during sediment remediation

Sediment remediation would cause harm to listed species through the resuspension of toxic compounds found in contaminated sediments. The amount of disturbed area is directly related to the amount of incidental take caused by resuspension because the level of contaminants resuspended increases with the area disturbed. This indicator can be reasonably and reliably measured and monitored by applicants. The Corps has not proposed to authorize this activity in recent requests for consultation. To determine the likely size of future sediment remediation projects, NMFS consider recent consultation requests on this activity from the Environmental Protection Agency. Their requests are typically for less than 50 acres of remediation. Assuming projects would not exceed this size, the extent of take caused by resuspension of contaminants during sediment remediation would be exceeded if more than 50 acres are remediated annually.

The surrogate measures of incidental take identified in this section can be reasonably and reliably measured and monitored by applicants. Additionally, these surrogates can be tracked by the Corps in real time and the Corps will know when the surrogates are exceeded or being approached.

Table 18. Incidental take pathways and associated indicators of the amount or extent of incidental take.

Incidental Take Pathway	Amount or Extent of Incidental Take
Listed ESA Salmonids captured annually (number salvaged)	10,000 juvenile salmon, steelhead, and rockfish (capture of rockfish is likely to be uncommon) annually.
Pile Driving	Annually 1,400 piles would be repaired, replaced, installed. In addition, in the first two years of SSNP implementation, we expect 2,800 piles to be repaired, replaced, or installed annually. In total, we expected no more than 5,600 piles to be repaired, replaced, installed during the first two years of SSNP implementation.
Entrainment, injury, or death from dredging operations (cubic yards)	≤ 34,000 cubic yards of volume of material dredged for vessel access and ≤ 500 cubic yards of volume material dredged for functionality of culverts, intakes, and outfalls annually In the first two years of SSNP implementation, we expect up to 68, 000 cubic yards of volume of material to be dredged for vessel access and ≤ 1,000 cubic yards of volume material dredged for functionality annually. In total, we expect no more than 136,000 cubic yards of volume of material to be dredged for vessel access and ≤ 2,000 cubic yards of volume material dredged for functionality during the first two years of SSNP implementation.
Harm caused by shoreline modification (bulkhead, etc.)	24,000 linear feet repair, replaced, installed (new) annually Up to 48, 000 linear feet repair, replaced, installed (new) annually during the first two years of SSNP implementation. In total, we expect no more than 98,000 linear feet of shoreline modification will be repaired, replaced, installed during the first two years of SSNP implementation.
Visible suspended sediment (turbidity) and small amounts of contaminants released during in-water construction and dredging	turbidity levels shall not exceed 5 nephelometric turbidity units (NTUs) more than background turbidity when the background turbidity is 50 NTUs (monitored and reported to NMFS and the Corps) or less, or there shall not be more than a 10 percent increase in turbidity when the background turbidity is more than 50 NTUs

Incidental Take Pathway	Amount or Extent of Incidental Take
Stormwater management	NMFS review and verification of stormwater management plan and stormwater information provided prior to the Corps authorizing or carrying out a project
Harm due to the presence of in-water and over-water structures and vessel impacts	220,000 square feet of in-or over-water structure from new, repair, or replacement annually Up to 440,000 square feet of in-or over-water structure from new, repair, or replacement annually during the first two years of SSNP implementation. In those first two years, we expect a total of no more than 880,000 square feet of in-or over-water structure will be repaired, replaced, or constructed (new).
Harm caused by resuspension of contaminants during sediment remediation	50 acres of area remediated annually There are no sediment remediation projects in the group of pending consultations, so no additional extent of take is predicted

2.9.2 Effect of the Take

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

2.9.3 Reasonable and Prudent Measures

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

The following measures are necessary and appropriate to minimize the impact of incidental take of listed species from the SSNP proposed action.

1. Minimize incidental take by ensuring that all applicable design criteria, general construction measures, and other requirements of the proposed action are applied for projects carried out under the SSNP programmatic action.
2. Ensure completion of a monitoring and reporting program
3. All applicants shall report and monitor for incidental take pathways that extend beyond the Corps jurisdiction or authority to NMFS (i.e. the maintenance of stormwater facilities).

2.9.4 Terms and Conditions

In order to be exempt from the prohibitions of section 9 of the ESA, the Federal action agency must comply (or must ensure that any permittee complies) with the following terms and conditions. The Corps or any permittee 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 reasonable and prudent measure #1:
    a. Applicants shall report any noncompliance with applicable design criteria, general construction measures, or other requirements to NMFS[67] and the Corps. The requirement to report noncompliance applies to all activities regardless of Corps authority or jurisdiction.
    b. The Corps shall include compliance with the proposed action and this incidental take statement as a condition of the Corps permit for projects authorized under SSNP.
2. To implement reasonable and prudent measure #2:
    a. The Corps shall follow Program Administration # 10 (Monitoring and reporting)
    b. The Corps shall ensure that amount and extent of incidental take as expressed above are not exceeded by tracking and reporting the on metrics in Table 17 annually.
    c. To ensure the extent of take for turbidity is not exceeded. The permittee shall:
        i. For in-water construction: Implement the best management practices and conservation measures by conducting water quality monitoring during structure removal and construction activities. At point of compliance (per state permit), turbidity levels shall not exceed 5 nephelometric turbidity units (NTUs) more than background turbidity when the background turbidity is 50 NTUs or less, or there shall not be more than a 10 percent increase in turbidity when the background turbidity is more than 50 NTUs
        ii. For dredging: Comply with Washington State water quality standards by conducting water quality monitoring during dredging activities. At point of compliance (per state permit), turbidity levels shall not exceed 5 nephelometric turbidity units (NTUs) more than background turbidity when the background turbidity is 50 NTUs or less, or there shall not be more than a 10 percent increase in turbidity when the background turbidity is more than 50 NTUs.
3. To implement reasonable and prudent measure #3, permittees shall:
    a. For projects requiring compliance with GCM #13, all applicants will inspect and maintain stormwater facilities to ensure that the facilities are functioning consistent with the verified PCSMP. Specifically, applicants shall:
        i. Inspect and maintain each part of the stormwater system, including the catch basin and flow-through planters, at least quarterly for the first three years, at least twice a year thereafter, and within 48-hours of a major

[67] Report to NMFS at: ssnp-wa@noaa.gov

storm event, i.e., a storm event with greater than or equal to 1.0 inch of rain during a 24-hour period (City of Portland 2008a; Valentine 2012).

ii. Ensure all stormwater drains out of the catch basin within 24-hours after rainfall ends, and out of the flow-through planter within 48-hours after rainfall ends.

iii. Ensure all structural components, including inlets and outlets, freely convey stormwater.

iv. Ensure desirable vegetation in the flow-through planter cover at least 90 percent of the facility – excluding dead or stressed vegetation, dry grass or other plants, and weeds.

v. Maintain records of inspection and maintenance to document compliance with this term and condition. Records do not need to be provided to NMFS unless requested.

vi. Report any non-compliance with the PCSMP as required by GCM#13 to NMFS.

2.10. Conservation Recommendations

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

1. The Corps should encourage permittees with public boat ramps authorized under SSNP to have a sign to educate the public about pollution from boating activities and its prevention, the Corps should request that permittees the post following information or its equivalent on a permanent sign at facilities that is used by the public (e.g., a public boat launch ramp):
   i. A description of the ESA-listed species which are or may be present in the project area.
   ii. Notice that adults and juveniles of these species are protected by the ESA and other laws so that they can successfully migrate, spawn, rear, and complete other behaviors necessary for their recovery.
   iii. Therefore, all users of the facility are encouraged or required to: (1) follow procedures and rules governing use of sewage pump-out facilities; (2) minimize the fuel and oil released into surface waters during fueling, and from bilges and gas tanks; (3) avoid cleaning boat hulls in the water to prevent the release of cleaner, paint and solvent; (4) practice sound fish cleaning and waste management, including proper disposal of fish waste; (5) dispose of all solid and liquid waste produced while boating in a proper facility away from surface waters, and (6) avoid disturbing spawning fish or redds.

Please notify NMFS if the permittee carries out these recommendations so that we will be kept informed of actions that minimize or avoid adverse effects and those that benefit the listed species or their designated critical habitats.

2.11. Reinitiation of Consultation

This concludes formal consultation for SSNP. Under 50 CFR 402.16(a): "Reinitiation of consultation is required and shall be requested by the Federal agency or by NMFS where discretionary Federal agency involvement or control over the action has been retained or is authorized by law and: (1) If the amount or extent of taking specified in the incidental take statement is exceeded; (2) If new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not previously considered; (3) If the identified action is subsequently modified in a manner that causes an effect to the listed species or critical habitat that was not considered in the biological opinion or written concurrence; or (4) If a new species is listed or critical habitat designated that may be affected by the identified action."

2.12. "Not Likely to Adversely Affect" Determinations

2.11.1 Green Sturgeon and their Designated Critical Habitat

Critical habitat was designated for the southern DPS of green sturgeon in 2009 (74 FR 52299; October 9, 2009) In the designation documents, Puget Sound is identified as an occupied area possessing PBFs for this DPS of green sturgeon, however Puget Sound is excluded from the designation for economic reasons. Observations of green sturgeon in Puget Sound are much less common compared to the other estuaries in Washington. Although two confirmed Southern DPS fish were detected there in 2006, the extent to which Southern DPS green sturgeon use Puget Sound remains uncertain. Puget Sound has a long history of commercial and recreational fishing and fishery-independent monitoring of other species that use habitats similar to those of green sturgeon, but very few green sturgeon have been observed there. In addition, Puget Sound does not appear to be part of the coastal migratory corridor that Southern DPS fish use to reach overwintering grounds north of Vancouver Island thus corroborating the assertion that Southern DPS do not use Puget Sound extensively. Because critical habitat is not designated in the action area, effects of projects authorized under SSNP on critical habitat are discountable.

As for any potential effect on the species, even if green sturgeon are present in the action area of Puget Sound, they rely on deep bottom areas for feeding and rearing, indicating that the effects of the project authorized under SSNP will be attenuated to the degree that exposure to effects will be at low enough levels that response will be insignificant. It is very unlikely that green sturgeon will occur in the near project areas or be exposed to stressors from the proposed action. Therefore, we conclude that the effects to the southern DPS green sturgeon are likely to be fully discountable.

2.11.2 Humpback Whales and their Designated Critical Habitat

Humpback whales were listed as endangered under the Endangered Species Conservation Act in June, 1970 (35 FR 18319), and remained listed after the passage of the ESA in 1973 (35 FR 8491). Humpbacks are divided globally by NMFS into 14 DPSs and place four DPSs (Western North Pacific, Arabian Sea, Cape Verde/Northwest Africa, and Central America) as endangered and one (Mexico DPS) as threatened (81 FR 62259). Photo-identification and modeling efforts indicate that a large proportion of humpback whales feeding along the coasts of northern

Washington and southern British Columbia are from the Hawaii DPS (63.5 percent), with fewer animals from the Mexico (27.9 percent) and Central America (8.7 percent) DPSs (Wade 2017).

Critical habitat was designated for humpback whale DPSs in April, 2021 (86 FR 21082). Critical habitat for the Central America DPS and Mexico DPS of the humpback whale extends from the Pacific Ocean into the Strait of Juan de Fuca, to Angeles Point, just west of Port Angeles. Critical habitat encompasses off shore areas up to 1200 meters with the shoreward boundary at 50 meters. The action area for this consultation overlaps with critical habitat for Central America DPS and Mexico DPS of the humpback whales in the Strait of Juan de Fuca. The physical and biological feature of humpback critical habitat is prey availability.

Data has not been collected on the proportion of DPSs within the Salish Sea, but it may be similar to coastal populations. For our analysis, we consider humpback whales migrating or foraging off the coast or in inland waters of Washington to primarily originate from the listed Mexico or non-listed Hawaii DPSs, with a smaller proportion being Central America humpback whales, following Wade (2017 and 2021). However, because of limited data availability for the Puget Sound proper, we have presented our humpback whale text outside of the scope of DPS. With current limited data, any individual humpback in the Puget Sound proper should be assumed to be part of a listed population, unless proven otherwise.

Numbers of humpback whales have been growing annually at a rate of 6-7.5 percent off the U.S. West Coast (Carretta et al. 2020; Calambokidis and Barlow 2020). Humpback whale sightings in the Salish Sea have also been increasing since the early 2000s (Calambokidis et al. 2018). Humpbacks may be entering the Salish Sea as a foraging or rearing opportunity along their migration from summer feeding grounds to winter breeding grounds. Alternatively, there are indications that some humpbacks may overwinter entirely within the Salish Sea. Existing sighting data in the Puget Sound proper is not reliable distribution data and may be skewed to warm weather, when more people are likely to be whale watching. Sightings in recent years have most mostly occurred from May through October, which overlaps with project construction windows. Despite increases in sightings of humpback whales in the Puget Sound, scientific survey data indicate that the highest densities of humpback whales occur within the Strait of Juan de Fuca up to Port Angeles with only intermittent use of the Puget Sound (pers. comm., John Calambokidis, Cascadia Research Collective, February 26, 2020 cited in 86 FR 21082). The likelihood of exposure of humpbacks to the temporary effects associated with the actions is low due to low whale density outside the Strait. Design criteria for marine monitoring and stop-work on sighting as described above for SRKW apply to all marine mammals, including humpback whales. They are intended to ensure that humpbacks will not experience duration or intensity of pile driving. Because the likelihood of exposure of any individual humpback whale to project work is low, and marine mammal monitoring plans will be in place for projects, effects on this species are discountable.

We considered long-term effects to humpbacks in light of the recent designation of critical habitat in the Strait of Juan de Fuca and increased sightings in the Salish Sea. Humpback whales in the North Pacific are vulnerable to entanglement in fishing gear and marine debris, ship strikes, human-generated marine sound, the effects of climate change, and for the Central America DPS, possible issues related to small population size (Sato and Wiles 2021). Coinciding with possible long-term effect pathways from the proposed group of projects in this Opinion, we have examined possible effects related to recreational vessel strikes, marine noise associated with vessel use, decreased forage availability, and contamination from pollutants. Effects from entanglement were discounted because few commercial fishing vessels are expected to be associated with structures repaired, replaced, or constructed under SSNP.

Decreased Forage Availability

Humpback whales are generalist feeders, and may show regional prey preferences. The whales are known to shift prey between krill and fish along the US West Coast and these shifts seem to match the relative abundance of prey and are reflected in changes in stable isotope concentrations from skin samples taken in biopsies of whales (Fleming et al. 2016). No studies have yet been conducted on the feeding preferences of humpback whales within the Salish Sea. Humpbacks forage and switch between target prey depending on what is most abundant or of highest quality in the system (Fleming et al. 2016) and it is possible that humpbacks enter the Salish Sea in search of dense congregations of prey such as krill and other forage fish like sand lance, and herring. Because humpbacks are opportunistic foragers, however, the small decrease in the number of forage fish available in the entire Salish Sea due to the proposed action is not likely to adversely affect their overall food supply. Krill are planktonic, and do not rely on the nearshore environment in a substantial way for their life cycle, therefore will not be affected by the proposed actions. We expect that the whales will proportionally shift food sources in response to any decrease in forage fish, but the decrease in forage fish at project locations is also not expected to have a detectible effect on humpback food availability. Additionally, any projects resulting in an enduring loss of nearshore habitat quality are required to compensate for those effects through conservation offsets. Therefore, effects on humpbacks due to a decrease in forage fish are expected to be insignificant.

Contamination from Pollutants

Humpback whales can bioaccumulate lipophilic compounds (e.g., halogenated hydrocarbons) and pesticides (e.g., DDT) in their blubber, by feeding on contaminated prey (bioaccumulation) or inhalation in areas of high contaminant concentrations (Barrie et al. 1992; Wania and Mackay 1993).

Herring in the Puget Sound and Georgia Basin, a known humpback food source, have elevated pollutant levels in their bodies. And PCBs in herring in two Central/South Puget Sound locations were significantly greater than three northern locations (O'Neill et al. 2001).

Although there has been substantial research on the identification and quantification of such contaminants on individual whales, including humpbacks, no detectable effect from contaminants has been identified in baleen whales. There may be chronic, sub-lethal impacts, but these are currently unknown. In the 2015 NMFS status review of humpback whales, contaminants were currently not considered an important threat to the Central America, Mexico, and Hawaii DPSs (Bettridge et al. 2015). Because no detectable effects of contaminants have been identified in humpback whales, the response is considered insignificant.

Vessel Noise

The proposed action either authorizes new or prolongs the life of marine structures. As a result, vessel traffic associated with the authorized structures is a consequence of the proposed action. As noted in the description of the action area for this consultation, these vessels are expected to operate in the Salish Sea.

Baleen whales rely on their acoustic sensory system for communicating with other individuals. Significant levels of anthropogenic sound can therefore interfere with communication by masking vocalizations. Vessel noise is a broadband signal which overlaps with the frequency band of many baleen whale vocal sounds (Richardson et al. 1995). Noise from vessel traffic has shown to cause variation in humpback whale behavior from changes in surface, foraging, and vocal behavior, displace animals from occupied areas, and produce temporary or permanent hearing damage and physiological stress. Nevertheless, responses by whales can vary depending on localized circumstances, sometimes with no observable reactions recorded. Where sound-related impacts are severe, reproduction and survival of animals may be affected (Clark et al. 2009).

In response to noise, humpback whales have been found to move away from noise sources (Dunlop et al. 2016), reduce male singing activity (Sousa-Lima and Clark 2008, Risch et al. 2012), reduce feeding activity (Sivle et al. 2015), and alter their migration path and speed (Dunlop et al. 2015, 2016). Williams et al. (2014) found coastal marine noise levels high enough to potentially cause significant communication problems for humpback whales at several locations in British Columbia, including Haro Strait in the Salish Sea adjacent to Washington. Schuler et al. (2019) found that feeding and traveling humpback whales were likely to maintain their behavioral state regardless of vessel presence, while surface active humpback whales were likely to transition to traveling in the presence of vessels. These short-term changes in movement and behavior in response to whale-watching vessels could lead to cumulative, long-term consequences, negatively impacting the health. Sprogis et al. (2020) showed vessel noise as a driver of significant behavioral response in humpback whales while simulating whale watching scenarios. During high noise playbacks on mother/calf pairs, the mother's proportion of time resting decreased by 30 percent, respiration rate doubled, and swim speed increased by 37 percent.

Small crafts with high-speed engines and propellers generally produce higher frequency noise than large vessels (Erbe 2002, Erbe et al. 2013). Large vessels, including cruise ships and tour vessels, generate substantial low frequency noise (Arveson & Vendittis 2000). Because of their low frequency, large vessels have more potential to cause noise-related effects to humpback whales.

Based on data available in 2015, the threat of anthropogenic noise received a "low" rating for all DPSs of humpback whales in the recent NMFS Status Review (out of possible ratings of unknown, low, medium, high, and very high; Bettridge et al. 2015).

There are no state or federal laws that set a minimum distance between vessels and humpback whales in Washington. However, most vessels are not focused on whale watching and would have a short-term presence in any specific location and any behavioral disturbance from vessel noise would be short-term and minimal. This along with the relatively low density of individuals from the listed Humpback DPSs in the action area create a low level of potential disturbance from vessel noise. For vessels that are engaged in whale watching, there are widely promoted Be Whale Wise viewing guidelines that recommend all vessels remain at least 100 yards away from large whales. Therefore, we expect any humpback whale response to vessel noise associated with the action to be short-term and minimal and therefore is considered insignificant.

Vessel Strikes

Members of the Mexico and Central America DPSs are expected to face increasing vessel traffic in the Puget Sound proper due to increasing population and coinciding vessel use. Ship strike risk may expand in these areas as vessel traffic intensifies in the future and humpback numbers increase. The proposed actions would maintain and expand existing vessel (less than 75ft) traffic in the Puget Sound proper.

Structure authorized under SSNP would be either residential, commercial, or industrial structures that support motorized boating with the potential to extend throughout the Salish Sea. The vessels associated with these structures would be mostly recreational boat, but would also include Coast Guard vessels, emergency vessels, and commercial vessels. For larger vessels, coastal studies of vessel strikes show that humpback whales are particularly vulnerable due to their feeding methods near the surface and mother/calf pairs that stay near the surface. Of 292 recorded strikes contained in the Jensen and Silber (2003) West Coast database, 44 were of humpback whales, second only to fin whales. According to a NMFS West Coast Region whale collision database, there have been 31 documented humpback whale strikes by vessels in the state of Washington since 1995. However, for smaller vessels, there are no known cases of a recreational vessel strike of a humpback in Puget Sound (Pers. comm., Hanna Miller, NMFS, 5/17/2021). Currently there is not a reliable dataset documenting smaller recreational vessels striking humpback whales in the Salish Sea, though numbers are likely very low due to low densities of the species and the high mobility of the vessels. In the past several years, documented humpback whale strikes have occurred in association with large vessels, such as the Bainbridge Island ferry in May 2019 (NWPB 2019), and the Whidbey Island ferry in July 2020 (Cascadia Research Collective 2020). These collisions have resulted in the assumed fatality of the individual. Much of the vessel use caused by the SNNP proposed action would be primarily recreational (marinas and residential structures) and no documentation of recreational vessel strikes to humpback whales exists in Washington. These factors combined with the whales' relative low density in the Puget Sound proper, make exposure to vessel strikes discountable.

2.11.3 Eulachon and their Designated Critical Habitat

The southern DPS of eulachon was listed as threatened on March 18, 2010 (75 FR 13012) and critical habitat was designated on October 20, 2011 (76 FR 65323). Southern DPS eulachon migrate through the Strait of Juan de Fuca on their migrations to and from spawning grounds in the Fraser River in British Columbia, and the Elwha River in Washington (NMFS 2017b). The Elwha River is the only known spawning site in the action area, and also the only designated critical habitat within the action area. Much of the Elwha River is located in Olympic National Park, with the remainder of the river flow through a moderately developed rural area. The action area for this consultation extends upriver on the Elwha only to the point of saltwater influence. In this location, the Elwha is gravel-bed river in a forest setting. The activity types included as part of SSNP primarily occur in nearshore marine areas and estuaries. The likelihood that one of these activities would be authorized under SSNP in the saltwater influenced portion of Elwha River is highly unlikey.

In marine areas, eulachon occupy nearshore waters to approximately 1,000 feet in depth. Dealy and Hodes (2019) did extensive eulachon sampling on the Canadian side of the Strait of Juan de Fuca and found that Strait likely provides important year-round habitat for feeding and growth, as well as being a migration corridor. In Puget Sound proper (south of Admiralty Inlet), there are no rivers hosting spawning runs of eulachon and the presence of eulachon appears to be rare (Gustafson et al 2010). Over the continental shelf, it is generally believed that eulachon stay at depth (approximately 100 to 200 meters deep) and rarely come to the surface. In the Strait of Juan de Fuca, Dealy and Hodes (2019) caught eulachon at depths of 81 to 227 meters, with the highest catch per unit effort at bottom depths of between 117 and 170 meters. However, as demonstrated during night-time surface trawls in the Columbia River plume, they may occur near the surface at natal river mouths and estuaries (Litz et al. 2014). Larval eulachon may also be distributed by prevailing currents in the action area, but would be most concentrated near natal river mouths and estuaries.

The PBFs for southern DPS eulachon critical habitat that may occur within the action area include:

- Freshwater spawning and incubation sites with water flow, quality and temperature conditions and substrate supporting spawning and incubation.
- Freshwater and estuarine migration corridors free of obstruction with water flow, quality and temperature conditions supporting larval and adult mobility, and with abundant prey items supporting larval feeding after the yolk sac is depleted.

Within the action area, critical habitat for southern DPS eulachon is only designated within the Elwha River. As explained above, no projects authorized under SSNP are likely to occur in the Elwha River. No effects from project occurring elsewhere are likely to extend upriver into eulachon critical habitat. Therefore, all effects of the proposed programmatic action are discountable for eulachon critical habitat.

Because there are no natal streams in Puget Sound, the occurrence of eulachon, either adult or juvenile, near projects sites in Puget Sound is very unlikely. In the Strait of Juan de Fuca and North Puget Sound, it is possible eulachon could be found near project sites. However, given their depth preference in marine waters, we do not expect eulachon to be close enough to project sites to be affected by construction impacts (e.g., noise, turbidity). Likewise, because of the eulachon preference for deep waters, we do not expect vessels to have any effect on eulachon. The risk of exposure of eulachon at any life stage to these effects is discountable. We also do not expect water quality to be degraded to such a degree that any eulachon would be affected in any measurable way. Any water quality effects from the proposed action on eulachon would be insignificant.

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

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

This analysis is based, in part, on the SSNP proposed action provided by the Corps and descriptions of EFH for Pacific Coast groundfish (Pacific Fishery Management Council (PFMC 2005), coastal pelagic species (CPS) (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 entire action area of the Salish Sea fully overlaps with identified EFH for Pacific Coast groundfish, coastal pelagic species, and Pacific Coast salmon.

3.2. Adverse Effects on Essential Fish Habitat

The proposed action for SSNP includes a number of activities that would degrade the quality of EFH. such as: (1) construction of, repair and replacement of in-water and overwater structures: (2) shoreline modification; and (3) dredging. These activities require conservation offsets to compensate for the loss of habitat quality in nearshore areas. These nearshore areas are EFH for multiple species. Although the offsets are intended to avoid the net-loss of habitat quality, the adverse effects still result from the activity categories identified above. The EFH recommendations below are intended to provide avoidance and minimization measures that go beyond the SSNP proposed action.

Alterations to the nearshore light, wave energy, and substrate regimes affect the nature of EFH and nearshore food webs that are important to a wide variety of marine finfish and shellfish (Armstrong et al.1987, Beal 2018; Burdick and Short 1995, Cardwell and Koons 1981, Kenworthy and Haunert 1991, Olson et al. 1996, Parametrix and Battelle 1996, Penttila and Doty

1990, Shafer 1999; Simenstad et al. 1979, 1980, 1998, Thom and Shreffler 1996, Weitkamp 1991).

The effects of the proposed action on ESA-listed species are described in Section 2.4 of the ESA analysis above. The same mechanisms of effect are likely to affect all Pacific Coast groundfish, coastal pelagic species, and Pacific Coast salmon to varying degrees. Some additional adverse effects include:

1. Water quality – both temporary (during construction) and permanent. Examples include sound, turbidity, enduring contaminants, and stormwater pollutants.

Additionally, copper-based paints are frequently used on vessel hulls in marine environments as an antifouling agent. These pesticidal paints slowly leach copper from the hull in order to deter attachment of fouling species, which may slow boats and increase fuel consumption. Copper that is leached into the marine environment does not break down and may accumulate in aquatic organisms, particularly in systems with poor tidal flushing. At low concentrations, metals such as copper may inhibit development and reproduction of marine organisms, and at high concentrations they can directly contaminate and kill fish and invertebrates. In coho salmon, low levels of copper have been shown to cause olfactory impairment, affecting their predator avoidance and survival (McIntyre 2012). These metals have been found to adversely impact phytoplankton (NEFMC 1998), larval development in haddock, and reduced hatch rates in winter flounder (Bodammer 1981, Klein-MacPhee et al. 1984). Other animals can acquire elevated levels of copper indirectly through trophic transfer, and may exhibit toxic effects at the cellular level (DNA damage), tissue level (pathology), organism level (reduced growth, altered behavior and mortality), and community level (reduced abundance, reduced species richness, and reduced diversity) (Weis et al. 1998, Weis and Weis 2004, Eisler 2000).

2. Forage reduction – disturbance and shading of SAV can result in reduction in SAV density and abundance, and related primary production. Designated EFH will experience temporary, episodic, and enduring declines in forage or prey communities.

Whitney and Darley (1983) found that microalgal communities in shaded areas are generally less productive than unshaded areas, with productivity positively correlated with ambient irradiance. Stutes et al. (2006) found a significant effect of shading on both sediment primary production and metabolism (i.e. sediment respiration). Intertidal salt marsh plants are also impacted by shading: the density of *Spartina alterniflora* was significantly lower under docks than adjacent to docks in South Carolina estuaries, with stem densities decreased by 71 percent (Sanger et al. 2004). Kearny et al. (1983) found the *S. alterniflora* was completely shaded out under docks that were less than 40 cm high and that the elimination of the macrophytic communities under the docks ultimately led to increased sediment erosion. Thom et al. (2008) evaluated the effects of short- and long-term reductions in submarine light reaching eelgrass in the Pacific Northwest, especially related to turbidity and overwater structures. They found that lower light levels may result in larger and less dense plants and provided light requirements for the protection and restoration of eelgrass.

Reductions in benthic primary productivity may in turn adversely affect invertebrate distribution patterns. For example, Struck et al. (2004) observed invertebrate densities under bridges at 25-52 percent of those observed at adjacent unshaded sites. These results were found to be correlated with diminished macrophyte biomass, a direct result of increased shading. Overwater structures that attenuate light may adversely affect estuarine marsh food webs by reducing macrophyte growth, soil organic carbon, and altering the density and diversity of benthic invertebrates (Whitcraft and Levin 2007). Reductions in primary and invertebrate productivity may additionally limit available prey resources to federally managed fish species and other important commercial and recreational species. Prey resource limitations likely impact movement patterns and the survival of many juvenile fish species. Adverse impacts to estuarine productivity may, therefore, have effects that cascade through the nearshore food web.

Fishes rely on visual cues for spatial orientation, prey capture, schooling, predator avoidance, and migration. Juvenile and larval fish are primarily visual feeders with starvation being the major cause of larval mortality in marine fish populations. Survival at early life history stages is often critical in determining recruitment and survival at subsequent life stages, with survival linked to the ability to locate and capture prey and to avoid predation (Britt 2001). The reduced-light conditions found under overwater structures limit the ability of fishes, especially juveniles and larvae, to perform these essential activities. For example, Able et al. (1999) found that caged fish under piers had growth rates similar to those held in a laboratory setting without food. In contrast, growth rates of fish caged in pile fields and open water were significantly higher. Able et al. (1998) also demonstrated that juvenile fish abundance and species richness was significantly lower under piers in an urban estuary. Although some visual predators may use alternative modes of perception, feeding rates sufficient for growth in dark areas usually demand high prey concentrations and encounter rates (Grecay and Targett 1996). As coastal development and overwater structure expansion continues, the underwater light environment will continue to degrade, resulting in adverse effects to EFH and nearshore ecosystems.

3. Migration and passage - Designated salmon EFH will experience enduring incremental diminishment of safe migration. As mentioned in Section 2.4 above, in the marine nearshore, there is substantial evidence that OWS impede the nearshore movements of juvenile salmonids.

4. Shoreline armoring projects will reduce available nearshore habitat - Reduction in quality of nearshore habitat through removal of riparian vegetation and resulting reduction of allochthonous input to the nearshore. Armoring also degrades sediment conditions, forage base, and access to shallow water waterward of the structures. Furthermore, access to forage and shallow water habitat upland of the structures is prevented during high tides.

<u>EFH Adverse Effects Determination</u>

Based upon the analysis presented above and in Section 2 of this document, NMFS has determined that the activities that would be authorized under this programmatic consultation would adversely affect EFH for various federally-managed fish species under the Pacific Coast groundfish species, coastal pelagic species, and Pacific Coast salmon species FMPs. Moreover, projects authorized under SSNP will adversely affect estuary and seagrass HAPCs for Pacific Coast salmon and Pacific Coast groundfish.

3.3. Essential Fish Habitat Conservation Recommendations

NMFS determined that the following conservation recommendations are necessary to avoid, minimize, mitigate, or otherwise offset the impact of the proposed action on EFH.

General Recommendations

1. All projects resulting in a loss of eelgrass habitat, should be required to follow eelgrass mitigation monitoring requirements put forth in the Washington Department of Fish and Wildlife "Eelgrass/Macroalgae Habitat Interim Survey Guidelines"[68] unless it conflicts with Seattle District Corps guidelines, in which case the Corps guidelines apply.

2. As part of its application, permittees should describe how their proposal addresses the specific conservation recommendations identified below. NMFS recognizes that not all conservation recommendations will be relevant in all situations. Therefore, the proponent should clearly articulate when a particular recommendation is not applicable to the proposed project. Based upon the project application, the Corps should determine if the project implements appropriate conservation recommendations and, therefore, can be covered by this consultation.

Mooring Buoys

For all projects, the project proponent should strive to implement avoidance measures to the extent feasible. When avoidance measures are not feasible, minimization measures should be implemented. Although SSNP requires conservation offsets for overwater structures, avoidance and minimization of effects are preferable and why, therefore recommending the following.

Avoidance:

1. All new moorings buoys should be anchored in areas where SAV (e.g., eelgrass, kelp) habitat is absent. This will reduce adverse impacts to SAV. Additionally, all new mooring buoys should, to the maximum extent practicable, be in waters deep enough so that the bottom of the vessel remains a minimum of 18 inches off the substrate during extreme low tide events. This will reduce adverse grounding impacts to benthic habitat.

Minimization:

1. When repairing or replacing mooring buoys, located within SAV habitat should be of the type that use midline floats, where appropriate, to prevent chain scour to the substrate. This will reduce adverse impacts to SAV and other benthic habitat.

[68] https://wdfw.wa.gov/sites/default/files/publications/00714/wdfw00714.pdf

Pile Removal and Installation

Minimization:

1. Encircle the pile with a silt curtain that extends from the surface of the water to the substrate, where appropriate and feasible.

2. Drive piles during low tide periods when substrates are exposed in intertidal areas, where appropriate and feasible. This minimizes the direct impacts to fish from sound waves and minimizing the amount of sediments re-suspended in the water column.

Over- and in- water Structures

For all projects, the project proponent should strive to implement avoidance measures to the extent feasible. When avoidance measures are not feasible, minimization measures should be implemented.

Avoidance:

1. Any cross or transverse bracing should be placed above the plane of MHHW, where appropriate and feasible, to avoid impacts to water flow and circulation.

Minimization:

1. Minimize, to the maximum extent practicable, the footprint of the overwater structure.

2. Design structures in a north-south orientation, to the maximum extent practicable, to minimize persistent shading over the course of a diurnal cycle.

3. For residential dock and pier structures, the height of the structure above water should be a minimum of 5 feet above MHHW, where appropriate and feasible.

4. The use of floats should be minimized to the extent practicable and should be restricted to terminal platforms placed in deep water where appropriate and feasible and when the Corps determines there will not be a navigation hazard.

5. When breakwaters are required, floating breakwaters are preferred. Encourage seasonal use of breakwaters.

Nearshore Structures

Minimization

1. Use soft approaches (e.g., beach nourishment, soft or hybrid armoring, vegetative plantings, and placement of LWD) in lieu of “hard” shoreline stabilization and

modifications (such as concrete bulkheads and seawalls, concrete or rock revetments), where appropriate and feasible.

2. If planting in the riparian zone, use an adaptive management plan with ecological indicators and performance standards to oversee monitoring and ensure mitigation objectives are met, unless it is contrary to a Corps approved riparian planting plan.

3.4. Statutory Response Requirement

As required by section 305(b)(4)(B) of the MSA, the Corps must provide a detailed response in writing to NMFS within 30 days after receiving these EFH conservation recommendations. 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 timeframes for the federal agency response. The response must include a description of measures proposed by the agency for avoiding, mitigating, or 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)). If it is not possible to provide a substantive response within 30 days, the Seattle district should provide an interim response to NMFS, to be followed by the detailed response. The detailed response should be provided in a manner to ensure that it is received by NMFS at least 10 days prior to the final approval of the action.

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 Corps 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 Corps. Other interested users could include permit applicants, citizens of affected areas, and other parties interested in the conservation of the affected ESUs/DPS. Individual copies of this Opinion were provided to the Corps. The document will be available at the NOAA Library Institutional Repository [https://repository.library.noaa.gov/welcome]. The format and naming adheres to conventional standards for style.

4.2 Integrity

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

4.3 Objectivity

Information Product Category: Natural Resource Plan

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

Best Available Information: This consultation and supporting documents use the best available information, as referenced in the References section. The analyses in this Opinion and the 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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6. APPENDIX A

This appendix includes the NMFS' Puget Sound Nearshore Habitat Conservation Calculator User Guide. Users of this guide should check: https://www.fisheries.noaa.gov/resource/tool-app/puget-sound-nearshore-conservation-calculator to see if an updated version is available.

Puget Sound Nearshore Habitat Conservation Calculator
User Guide

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Abbreviations

DSAYs	Discounted Service Acre Years
DSZ	Deeper Shore Zone
EFH	Essential Fish Habitat
ESA	Endangered Species Act
GIS	Geographic Information System
HAT	Highest Astronomical Tide
HEA	Habitat Equivalency Analysis
LSZ	Lower Shore Zone
MHHW	Mean Higher High Water
MLLW	Mean Lower Low Water
NHVM	Nearshore Habitat Values Model
NOAA	National Oceanographic and Atmospheric Administration
NRDA	Natural Resource Damage Assessments
OWS	Overwater Structures
PS	Puget Sound
SAV	Submerged Aquatic Vegetation
SSNP	Salish Sea Nearshore Programmatic
USACE	US Army Corps of Engineers
USFWS	US Fish and Wildlife Service
USZ	Upper Shore Zone
WDOE	Washing State Department of Ecology
WDFW	Washington Department of Fish and Wildlife
WDNR	Washing State Department of Natural Resources

Definitions

Action Agency: Federal Agency seeking ESA section 7 consultation with the National Marine Fisheries Service or US Fish and Wildlife Service.

Conservation Credit (credit): A unit of measure (e.g., a functional or areal measure or other suitable metric) representing a gain in ecological functions for Puget Sound Chinook and Hood Canal summer-run chum at a mitigation site. The measure of ecological functions is based on the resources restored, established, enhanced, or preserved. As part of Puget Sound Nearshore consultations, a credit is determined using the Conservation Calculator or other Services and Action Agency approved habitat quantification tool.

Conservation Debit (debit): A unit of measure (e.g., a functional or areal measure or other suitable metric) representing the loss in ecological functions at an impacted site. The measure of ecological functions is based on the resources impacted.

Conservation Points: Conservation Points are Discounted Service Acre Years multiplied by 100. This creates more intuitive outputs for small impacts.

Discounted Service Acre Years (DSAYs): Measure of change in habitat services provided over a specific duration of time to a set of target species within the Habitat Equivalency Analysis (HEA) methodology.

Force Majeure: Unexpected circumstances including accidents and extreme weather that may damage structures.

Minor Maintenance: Minor servicing of an existing structure that does *not meaningfully prolong the life of the structure*. For minor maintenance, a structure must remain the same size and within its current footprint. Minor Maintenance activities do not have to be entered into the Conservation Calculator. Further, minor maintenance includes the repair and replacement of previously mitigated elements during the first half of their design life.

Repair: Partial replacement, reconstruction, or rehabilitation of a structure that meaningfully extends the life of that structure.

Replacements: Reconstruction of an identical or highly similar structure in the same location as the structure being replaced.

Service Area: The service area is the geographic area in which conservation credits and debits can be traded to ultimately offset the loss of salmonid resource functions.

Standalone Restoration: A standalone restoration project restores or improves habitat functions without introducing new, or temporally extending, adverse effects aside from construction-related effects. Standalone restoration projects include removal of a structure that has adverse effects but does not include any replacement.

Introduction to the Conservation Calculator

What is the Puget Sound Nearshore Conservation Calculator?

NOAA and the US Fish and Wildlife Service (USFWS), collectively "the Services," developed the Conservation Calculator as a user-accessible tool that simplifies the application of the Habitat Equivalency Analysis (HEA) and Nearshore Habitat Values Model (NHVM) (Figure 1). The goals of the Conservation Calculator are to:

- Quantify the habitat impacts relevant for Puget Sound (PS) Chinook salmon and Hood Canal summer-run chum from a proposed project and the habitat benefits from mitigation projects in terms of a common habitat metric.
- Allow the Services, Action Agencies, and project applicants to simultaneously and consistently apply both HEA and NHVM for proposed actions in the Puget Sound nearshore environment.
- Facilitate avoidance, minimization, and, where warranted or otherwise appropriate, no-net loss of nearshore habitat functions for PS Chinook salmon and Hood Canal summer-run chum by quantifying habitat impacts from proposed project actions (construction, repair, replacement, mitigation).

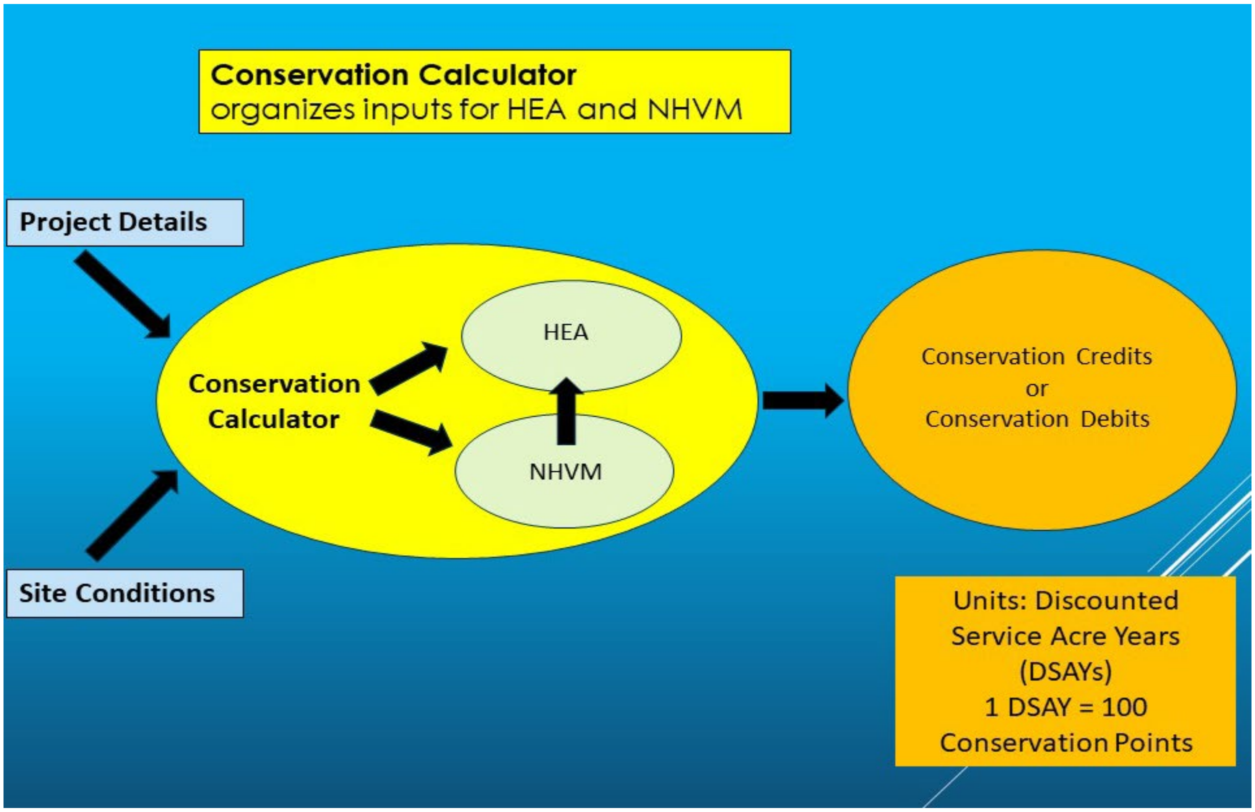


Figure 1. The Conservation Calculator is an interface for Habitat Equivalency Analysis (HEA) and the Nearshore Habitat Values Model (NHVM).

The Conservation Calculator is a user interface to the NHVM and HEA. It facilitates determination of **conservation debits** resulting from nearshore projects that decrease habitat function and **conservation credits** that are associated with projects that increase nearshore habitat function.

The Conservation Calculator allows the Services to assess habitat impacts and benefits in Puget Sound from several actions including:

1. Addition of new, replacement, and removal of overwater structures including piers, ramps, floats, house-boats, decks, piles, etc.
2. Removal of creosote
3. Addition of new, replacement, and removal of shoreline armoring
4. Addition of new, replacement, and removal of boat ramps, jetties, and rubble
5. Addition of new, and removal of riparian plantings
6. Addition of new submerged aquatic vegetation (SAV) plantings
7. Addition of forage fish spawning supplement/beach nourishment
8. Maintenance dredging

The Conservation Calculator is adaptable and allows the Services to make updates as new science or best available information becomes available. The Conservation Calculator also allows for expanding the types of analysis to account for the different types of nearshore development actions that could occur. (Note: These changes, if necessary, will be scheduled for predictable and regular updates. See below for specifics).

Habitat Equivalency Analysis

The **Habitat Equivalency Analysis (HEA)** methodology assesses impacts (net ecological loss) and benefits (net ecological gain) to the habitat. Ecological equivalency provides the basis of HEA as a concept that uses a common medium of exchange called **Discounted Service Acre Years (DSAYs)**. DSAYs express and assign a value to functional habitat loss and gain over a certain time period. Ecological equivalency is a service-to-service approach where the ecological habitat services relevant for a species or group of species impacted by an activity are fully offset by the services gained from a conservation activity. This is further explained in Ray (2008).

The NOAA Restoration Center developed HEA in cooperation with stakeholders and it has become a common method for Natural Resource Damage Assessments (NRDAs). NOAA's Central and North Puget Sound area offices chose the HEA methodology for its Endangered Species Act (ESA) consultations and developed the NHVM and Conservation Calculator to facilitate the use of the HEA model. Not only has HEA been successfully used in multiple NRDA proceedings, it also addresses temporal impacts of the design life of nearshore structures.

The use of HEA requires several input parameters including nearshore habitat values (Figure 2). Habitat values characterize the functions and value of a specific habitat for the target species before and after an impact/restoration. A team of NOAA biologists developed a NHVM to aid in determining these habitat values specific to juvenile PS Chinook salmon and Hood Canal summer-run chum. The NHVM's structure and values are specific to quantifying habitat conditions for the designated critical habitat of listed PS Chinook salmon and Hood Canal summer-run chum. The NHVM accounts for a range of habitat values (low to high depending on functionality and importance to the species). The NHVM design and values were derived from scientific literature and best available information, as required by the ESA. The resulting NHVM allows for consistent determination of habitat values across the Puget Sound nearshore through consideration of site-specific conditions.

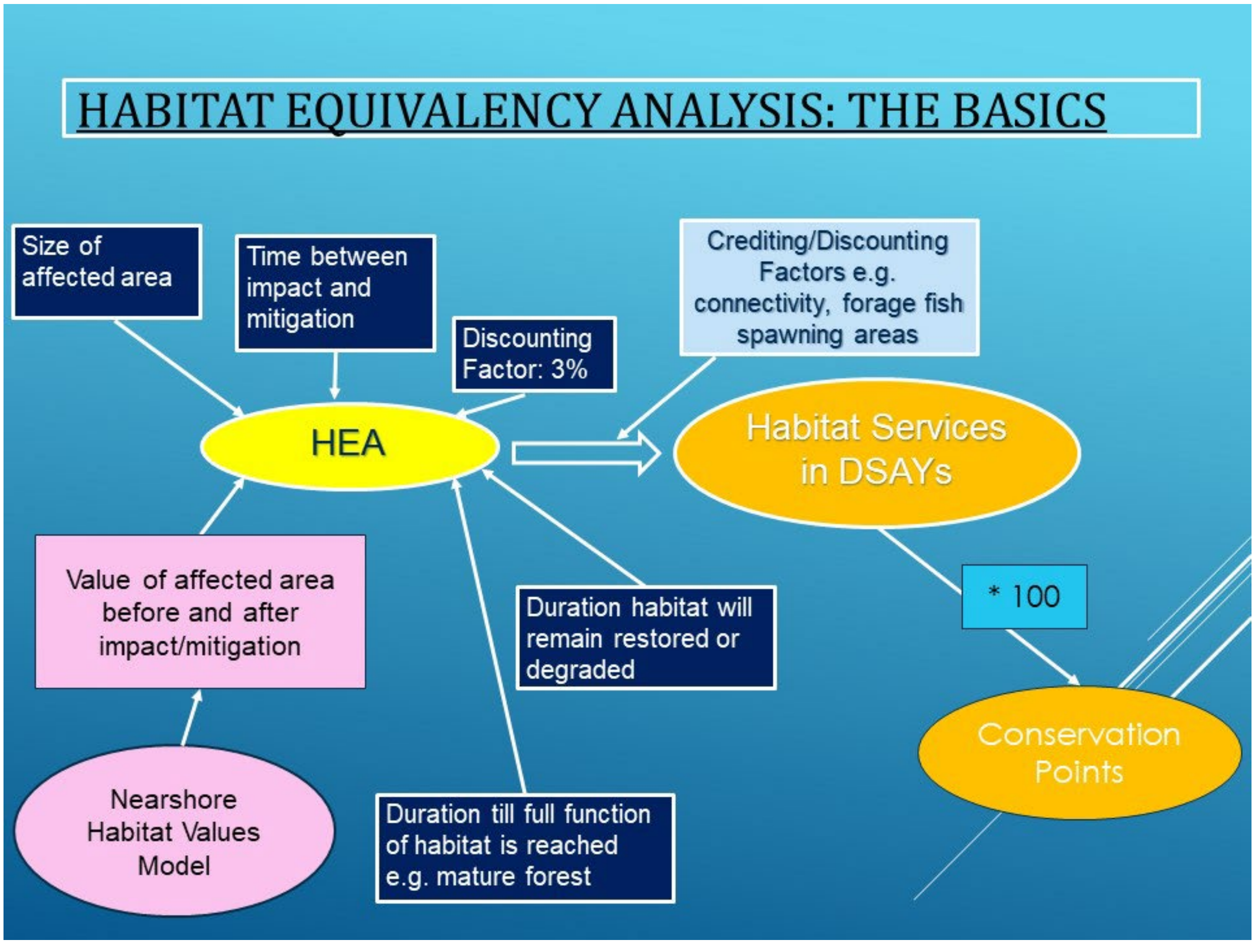


*Figure 2. Components of Habitat Equivalency Analysis (HEA). Inputs include nearshore habitat values (pink) and additional parameters (navy). Outputs (orange) include DSAYs – conservation credits or debits – and **Conservation Points**. Conservation points are DSAYs multiplied by 100 which allow the user to work with more intuitive outputs for small impacts.*

Nearshore Habitat Values Model

The NHVM determines the habitat value, by ranking the existing conditions of physical and biological functions of salmonid critical habitat (50 CFR 226.212) for each of five elevation zones (Figure 3) in the subject habitat. The physical and biological functions for marine and estuarine critical habitat used for the NHVM include the unobstructed migratory corridor, cover and primary production, sediment quality and quantity, and water quality.

We split the marine/estuarine nearshore into five elevation zones based on their accessibility and function for the target species. The **Riparian Zone (RZ)** extends 130 feet landward from HAT. This is the area we found most relevant for supporting water quality and food provisioning for salmonids (see *Tab 3: RZ (Riparian Zone)* for more information). The **Upper Shore Zone (USZ)** extends between HAT and plus five Mean Lower Low Water (MLLW). The USZ is further split into **USZ 1** and **USZ 2** with the USZ 1 extending from HAT to Mean Higher High Water (MHHW). The duration and extent of tidal inundation in the USZ 1 is very limited and thus salmonid access, as well as sand lance and surf smelt spawning, is generally limited to the USZ 2. Based on the reduced extent, frequency, and duration of aquatic access for those species, we assigned the USZ 1 a lower maximum habitat value than the USZ 2 (Figure 4). The **Lower Shore Zone (LSZ)** extends from plus five MLLW to the deepest extent of submerged aquatic vegetation (SAV). All SAV is contained in the LSZ. The **Deeper Shore Zone (DSZ)** begins at minus 10 feet MLLW or the lowest limit of SAV growth. There is no defined limit end to the DSZ.

The five different shore zones provide different maximum habitat values for juvenile PS Chinook salmon and Hood Canal summer-run chum. Habitat values range from a minimum of 0 to a maximum of 1. The maximum habitat values that each zone can provide is based on the maximum possible contribution of habitat functions in that zone (Figure 4). For juvenile salmonids in the marine nearshore – a maximum habitat value of 1 – is an eelgrass meadow or other dense SAV providing food, cover, and an unobstructed migratory corridor. While the DSZ also provides migratory corridor function and forage (via primary production and drift in) for juvenile salmonids, it generally produces less forage than the LSZ as it does not contain SAV. While the riparian zone is not used directly by salmonids, it provides important functions for juvenile salmonids including provision of food via allochthonous[5] input including insects. Corresponding maximum habitat values are shown in Figure 4.

[5] Allochthonous: Material that has been imported from outside of the system or considered area.

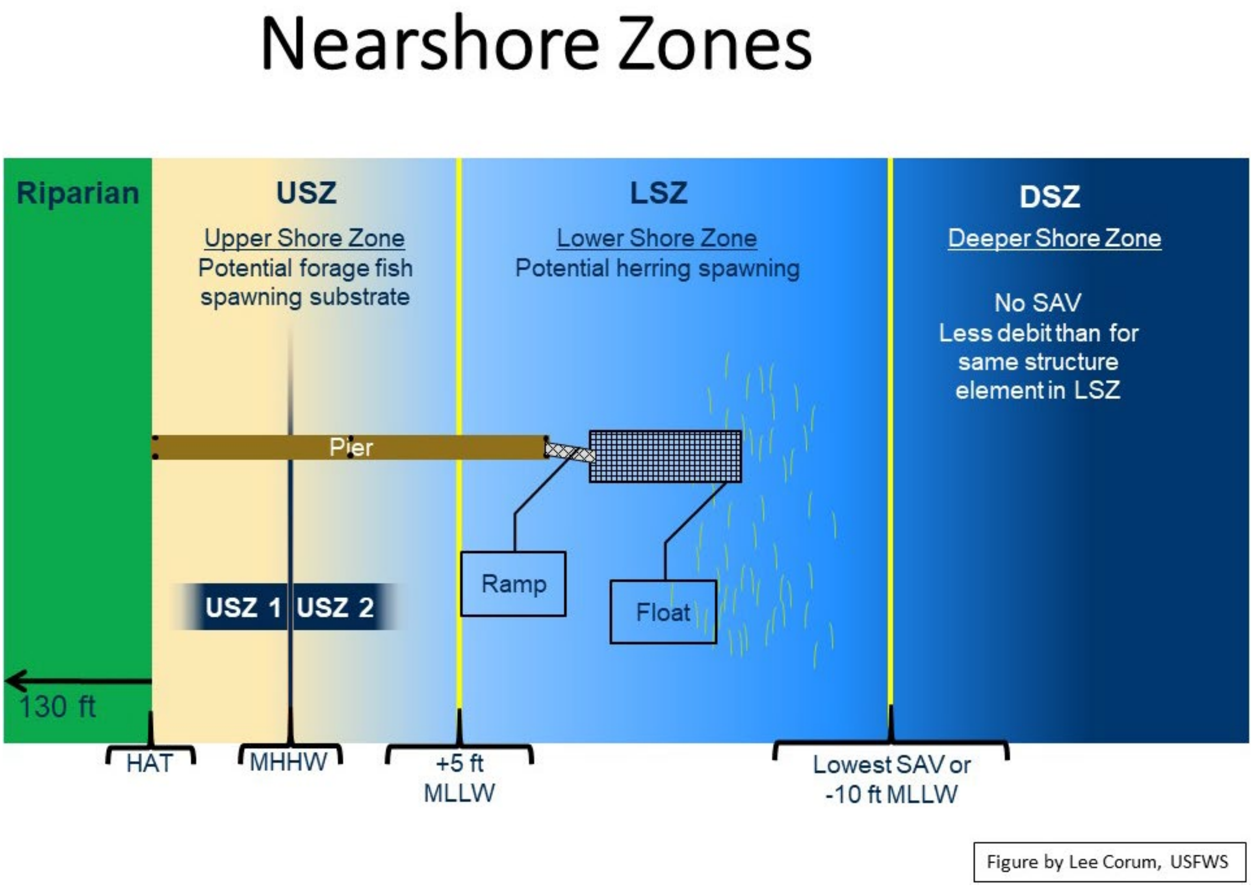


Figure 3. The Five Puget Sound Nearshore Zones. From highest to lowest elevation they are the Riparian Zone (RZ), Upper Shore Zone 1 (USZ 1), Upper Shore Zone 2 (USZ 2), Lower Shore Zone (LSZ), and Deeper Shore Zone (DSZ). Figure by Lee Corum, USFWS.

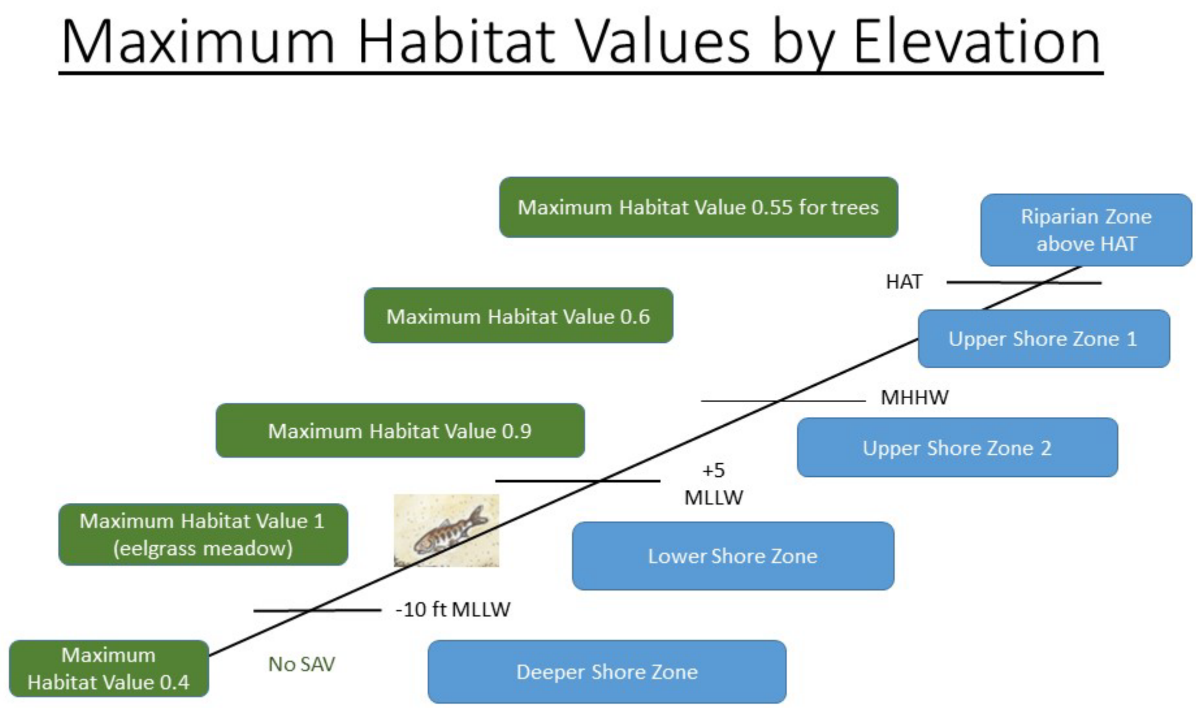


Figure 4. Maximum Habitat Values by Elevation. The corresponding nearshore zones are shown to the right. Values for each zone range from a minimum of 0 to a maximum of 1.

We mention these details to create an understanding about how some of the input requested for the Conservation Calculator is used. For example, to evaluate the cover and primary production in the LSZ, the NHVM uses presence and quality of SAV. For that evaluation, an assessment of the SAV condition via online resources or field surveys is needed.

Application of this Tool

The Conservation Calculator can be used to quantify habitat impacts for projects within marine and some estuarine environments of Puget Sound, including projects within the salt wedge[6] of riverine systems. The Conservation Calculator is not appropriate for application in estuarine environments that do not fall within the shoreline descriptions outlined above (Figure 3), such as tidally influenced wetlands with backwater channels. Project elements upstream of documented salt wedges are also not suitable to be evaluated by this Conservation Calculator.

Conservation Calculator outputs are based on the evaluation of changes in physical and biological functions and their indicators relevant for PS Chinook salmon and Hood Canal summer-run chum productivity and abundance. The evaluation framework is dependent on the

[6] The salt wedge is defined as the area of intrusion of salt water into a tidal estuary in the form of a wedge along the bed of the estuary.

existing HEA model and the NHVM. The evaluation of project related changes is based on best available science, context-specific application of ecological processes, and best professional judgment. As with most other rapid assessment methods (Adamus, P, K. Verble 2020), field verification requires periodic process improvement.

If submitting a Conservation Calculator with a consultation request, ensure that the most current version of the Conservation Calculator and user guide is being utilized. The Conservation Calculator will be updated February 1st of every calendar year to incorporate applicable new science, monitoring results, additional modules, or other procedural, design, or usability improvements.

Avoidance and Minimization

NOAA strongly encourages applicants and consultants to evaluate nearshore projects with the Conservation Calculator *prior* to engaging in ESA consultation. Consider options for reducing conservation debits before project submission by (1) reducing the size of the structure, (2) incorporating hybrid or soft armoring for bulkheads, and/or (3) evaluating possible restoration on-site or on adjacent properties. On-site offsets, such as creosote removal, riparian plantings, or structure removal, may not be enough to reduce all debits associated with high impact projects.

Best Management Practices for Structures Evaluated with the Conservation Calculator

To reduce project impacts and associated debits, applicants should strive to minimize habitat impacts associated with their nearshore structures. Minimizing the project footprint to the greatest possible extent and avoiding areas with greater habitat value reduces the associated conservation debits.

In detail, best management practices (BMPs) to minimize impacts include:

1. Minimize the total size (area) of coverage or linear feet of the structure.
2. Reduce shoreline armoring (seawalls, bulkheads, abutments).
    a. Instead of a traditional "hard armoring" bulkheads (concrete, steel, rock), use soft-shore or hybrid armoring whenever possible. The Washington State Department of Fish and Wildlife (WDFW) Your Marine Waterfront guide is a valuable resource for minimizing your environmental impact. Soft or hybrid armoring is not entered into the Conservation Calculator, and therefore does not accrue debits!
    b. Relocate shoreline armoring as far landward as possible to reduce impacts to the USZ. Armoring landward of HAT does not incur debits for placement of armoring, but may incur small debits related to impacts to riparian vegetation.
    c. Slope rock bulkheads landward and incorporate native woody plantings.

d. Place vulnerable structures (like homes) as far landward of the shoreline as possible to reduce dependence on shoreline modification.

3. Minimize impacts to SAV.
   a. Delineate SAV for the project area within 25 feet of proposed structures. If SAV is found within that area, then delineate the entire property and choose a location for the structures that demonstrates the greatest avoidance and minimization of vegetation.
   b. Floating structures should never "ground out" on the substrate, and stoppers/pin piles/feet should hold the structure at least 12 inches above the substrate.
   c. If SAV is present within 25 feet of the proposed float, the bottom side of the float must be elevated at least 4 feet above the substrate at low tide to reduce prop scour impacts on SAV.

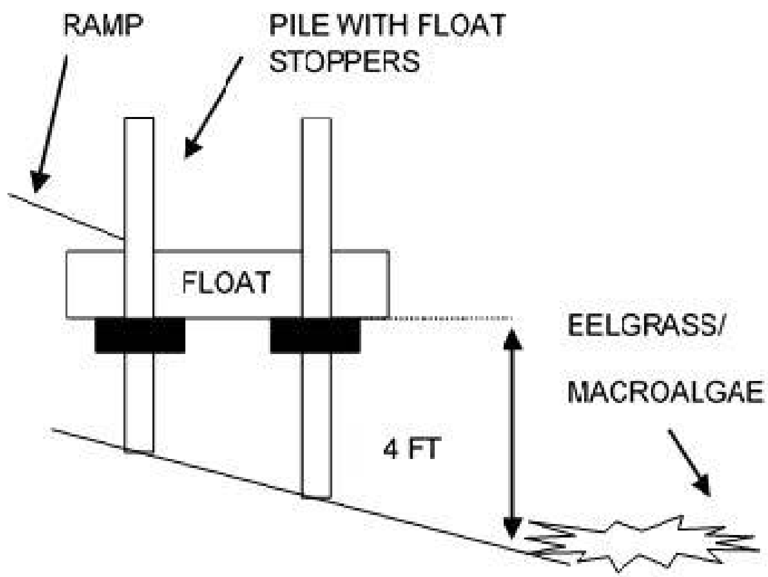


Figure 5. Proposed Float within 25 feet of SAV. Side-view. The bottom side of the float must be elevated at least 4 feet above the substrate at low tide.

   d. We request SAV field surveys for most replacement projects[7]. However, applicants should include a description of the SAV to the best of their ability using the following resources:
      i. Submit photographs of the LSZ taken at low tide between June 1 through October 1. An underwater camera (GoPro or equivalent) is ideal for photographing the LSZ area that is still underwater at low tide.
      ii. Washington Marine Vegetation Atlas from the Washington State Department of Natural Resources (WDNR)
      iii. Coastal Atlas mapping tool from the Washington Department of Ecology (WDOE)
      iv. Old SAV surveys and SAV surveys from adjacent areas.

[7] NMFS accepts field surveys that follow the WDFW SAV interim survey guidelines.

In the absence of a description, survey, or photos that provides reasonable certainty of a vegetation condition rating as described in this User Guide, NMFS biologists will assign an SAV score based on available data.

If the project area is located in areas with dense SAV or native eelgrass (*Zostera marina*) and avoidance and minimization of impacts cannot be achieved with on-line resources, a field survey and delineation may be required to demonstrate how the project will avoid and minimize impacts.

4. Minimize impacts to forage fish spawning substrate by avoiding spawning areas, which can be found using WDFW's Forage Fish Spawning map. If this is not possible, construct 100% grated piers and ramps over spawning habitat and minimize the number of piles in the USZ.
5. Maximize light penetration
   a. Pier surfaces and ramps should be entirely grated with at least 60% open space.
   b. Floats should be grated to the maximum extent possible. To qualify as a grated float in the Conservation Calculator, floats must have 50% effective grating with 60% or more open space (Compliant with WAC 220-660-280).
   c. Install a mooring buoy in the DSZ rather than a boat lift in the LSZ.
6. Minimize impacts from piers
   a. Minimize the width of the pier. We recommend a pier width of 4 feet for residential structures, and as narrow as possible for commercial structures (ADA compliance may impact how wide the structure must be).
   b. Piers should be a straight line rather than finger, "L," or "T" shaped.
   c. Do not construct additional structures on piers (i.e., buildings, planter boxes, slides, etc.). Solid structure areas must be entered in the Conservation Calculator as a solid pier, which has more habitat impacts than grated surfaces.
   d. Stairways should be open-frame construction and not solid structures (i.e., concrete). The width of stairway landings and steps should not exceed 4 feet for single-use and 6 feet for joint-use.

User Requirements

Use of the Conservation Calculator requires a moderate to substantial knowledge of nearshore ecology and coastal geology, and experience with field data collection methods including determining some tidal elevation. Field data that are necessary for use of the Conservation Calculator also include SAV surveys and forage fish surveys or appropriate use of existing information. Users will need to have experience with geographic information systems (GIS) or Google Earth, aerial photo interpretation, and/or field evaluation experience, depending on project type. Users will need to be able to interpret maps related to areas valuable for the target species including maps of natal estuaries, pocket estuaries,[8] WDOE's Coastal Atlas map at https://apps.ecology.wa.gov/coastalatlas/tools/Map.aspx, and WDFW's Forage Fish Spawning

[8] Map layers are provided on NOAA web page and as hot links in the Conservation Calculator

map at https://www.arcgis.com/home/item.html?id=19b8f74e2d41470cbd80b1af8dedd6b3. In addition, the user must have access to the internet and Microsoft Excel 2007 or later. Moderate Microsoft Excel knowledge allows for further understanding of equations used within the calculator.

Resources on NOAA's PS Nearshore web page at https://www.fisheries.noaa.gov/west-coast/habitat-conservation/puget-sound-nearshore-habitat-conservation-calculator, along with this user guide, provide information regarding the use of the Conservation Calculator. Further, pre-consultation technical assistance meetings can provide a venue for applicants and consultants to get help with more complicated projects. Email PSNearshoreConservation.WCR@noaa.gov for questions. NOAA will continue to provide training and technical assistance for use of the Conservation Calculator by adding training materials and updates to the PS Nearshore web page mentioned above.

Conservation Calculator as part of ESA Consultations in Puget Sound

The Conservation Calculator is a tool that can be used by agency staff, environmental consultants, non-profit and corporate staff, and project proponents. Users can download the Conservation Calculator and enter project specifications to determine credit and/or debits. Project specific Conservation Calculators are needed for most, if not all, Puget Sound nearshore projects. For example, no-net loss is required as part of the proposed action in the Salish Sea Nearshore Programmatic (SSNP) biological opinion. A tool to demonstrate no-net loss is the Conservation Calculator.

Conservation Calculator Process Improvements

The Services will apply new science, incorporate monitoring results, and process improvements to the Conservation Calculator, NHVM, and this user guide with thorough, regular and predictable updates.

Throughout the year, we encourage users to send improvement suggestions, new and relevant science, and potential bugs to PSNearshoreConservation.WCR@noaa.gov at NOAA and questions specific to USFWS species to (annelise_hill@fws.gov).

The Services plan to post any updates to the Conservation Calculator and user guide, if needed, on February 1st of every year. We document all updates and additions in a separate document, the Change Log, also available on our web page. In the event a more critical update would need to occur sooner, the Service will make every effort to update the website and user forums. Annual updates may include adjustments to credit factors, updates to maps related to the credit factors, and changes based on new science, policies, and feedback from applicants. Changes may also include improvements to the layout of the Conservation Calculator and user guide.

When a project specific Conservation Calculator is submitted as part of an ESA consultation initiation package, NMFS requests that applicants and their agent submit the most recent version of the Conservation Calculator posted on NMFS's web page. Once a project is initiated or for a programmatic implementation NMFS confirms that the project fits the programmatic, the project Conservation Calculator version is final and will stay with the project.

After the annual February Conservation Calculator update has been posted on PS Nearshore web page, applicants whose projects have not been initiated or whose programmatic implementation has not been confirmed by NMFS to fit a programmatic may amend their project file with a new Conservation Calculator using the updated February version.

Conservation Calculator Training

Materials from the January 2021 Conservation Calculator workshop are available on the PS Nearshore web page at https://www.fisheries.noaa.gov/west-coast/habitat-conservation/puget-sound-nearshore-habitat-conservation-calculator. We strongly encourage users to review this training before sending questions about calculator entry or requesting additional training. We plan to offer follow-up training. To receive updates regarding training, new material, updated versions of the Conservation Calculator and User Guide, sign up for our listserv on the PS Nearshore web page.

Conservation Offsets

Applicant-responsible Credit Generation

Conservation credits to offset impacts can be generated by engaging in **standalone restoration** actions. Applicant-generated conservation credits can be generated on the same site as a project causing debits or within the same service area. For example, an applicant may remove structures in the nearshore of the same service area of an impacting project to generate conservation credits to offset debits. The removal must be a standalone and separate action and cannot be integral to another project.[9] Standalone applicant-responsible credit generation includes:

- Removal of individual creosote piles not associated with a structure
- Removal of an overwater structure (either containing creosote or not)
- Removal of a portion of a structure[10]
- Removal of shoreline armoring (complete armoring, not a portion)
- Riparian plantings
- Beach nourishment

[9] Residual applicant-generated credits from a replacement project cannot be used as credits for a different debit project.

[10] Partial structure removal is limited to distinct portions that can be removed as a standalone project without increasing the environmental risk associated with the remaining portion of the structure.

Reporting for Applicant-responsible Credit Generation

Creosote: After creosote removal and upland disposal, applicants must submit the disposal receipts and a picture of the dump truck on the scale to the Services. Disposal receipts need to contain actual weight of the total removed creosote.

Removal Credits

The Conservation Calculator is set up to determine credit for the removal of existing structures and creosote. For existing structures, we make the average estimate that at the time of permit application, the existing structure would remain in lawful and in a structurally sound and good condition for a period of 10 years. If structures are non-functioning, deteriorated and/or falling apart, or otherwise not in good condition as required by their permit, removal credit is generally not justified.

A request for an emergency authorization usually indicates that a structure has not been maintained in a good condition. Conservation credit for the removal of structures under an emergency authorization may apply only in very limited circumstances. Projects that received an emergency authorization from the US Army Corps of Engineers (USACE) may receive credits for the removal of the old/existing structures if the structure was in good condition at the time of permit application and dated pictures can be provided.

Preservation of Existing Habitat

Stay tuned for February 2023, we are working on this.

Service Area

To effectively offset impacts, credits must originate from within the same **service area** as debits. Service areas may vary depending on the credit provider and extend as far upriver as the maximum extent of saltwater intrusion in river mouths. See the PS Nearshore web page for links to conservation credit provider specific service area maps.

General Information - Applicable to All Structure Entries

Replacements, Repairs, Minor Maintenance

For the purposes of SSNP, replacements, repairs, and minor maintenance are part of individual activity categories. SSNP activity categories that cover repairs and replacement and require conservation offsets are “Shoreline modifications” and “Repair or replace an existing structure.” “Repair or replace an existing structure” includes: Aids to navigation; boat houses; covered boat houses; boat garages; breakwaters; commercial; industrial and residential piers; pier, ramp, and floats; float plane hangars; floating walkways; groins and jetties; house boats; boat ramps;

wharfs, port, industrial and marina facilities; dolphins, float storage units, debris booms. "Minor maintenance of an existing structure" is a separate SSNP activity category and includes: Pile resets, replacement of rubber strips, encapsulation of flotation material, replacement of fender piles that do not contribute to the structural integrity of the structure, capping of piles, replacement of flat stops, height extension of existing piles. Minor maintenance, which does not meaningfully extend the life of a structure, does not require conservation offsets.

For filling out the calculator, **replacement** means reconstruction of an identical or highly similar structure in the same location as the structure being replaced. In general, the structure that is being replaced has to be in the environment at the point of permit application for an installation to be considered a replacement. Further, to receive removal credit for the existing structure, the existing structure has to be in good condition. For more information on removal credits, review the Removal Credits section above.

For filling out the calculator, **repair** means to conduct partial reconstruction or rehabilitation of a structure that meaningfully extends the life of that structure. Repairs have impacts on critical habitat that are similar to the impacts of replacements. Like replacements, repairs extend the duration of an impact to the nearshore into the future. Such repairs include: Resurfacing boat ramps and encasing bulkheads. Most repairs have very similar or the same environmental effects as replacements. Thus, removal credits apply to most repairs even if the existing structure is not removed for the same reasons as discussed above in Removal Credits.

"Piece by Piece" approach for replacements and repairs: Only the element to be repaired or replaced is entered into the Conservation Calculator. For example, if X square feet of a boat ramp are proposed to be replaced, only those X square feet are entered into the Conservation Calculator.

In more detail, to quantify impacts from repairs and partial replacements:

1. Enter the footprint of the existing structure element that is proposed to be repaired or replaced into Entry Block III for Removal, Removal as Part of Replacements, and Repair. Structure elements to be repaired are generally eligible for removal credit.
2. Enter the footprint of the proposed replaced/repaired structure element (which should not exceed the existing footprint) in Entry Block II for Repair and Replacement. If partial replacements and repairs include design changes or improvements, like an increase in grating, those should also be reflected in Entry Block II.
3. "No Double Offsets" when replacing structurally overlapping elements. This mostly applies to overwater structures and is discussed in more detail in the section on *Tab 4: Overwater Structures - Repair of Overwater Structures*.

When filling out the Conservation Calculator, **minor maintenance** activities do not have to be entered. Minor maintenance means carrying out minor servicing at an existing structure that we have determined at this time does not meaningfully extend the life of the structure. Maintenance activities include pile resets, capping of piles, replacement of rubber strips, replacement of float stops, encapsulation of existing floatation material, height extension of existing piles, and replacement of fender piles that do not contribute to the structural integrity of the structure.

Further, for filling out the Conservation Calculator, minor maintenance includes the repair and replacement of previously mitigated elements during the first half of their design life. This includes unexpected damages caused by a force majeure, if it occurs during the first half of the structure's design life. For these situations, the Conservation Calculator does not have to be used. If a structure or elements of a structure for which conservation offsets were previously provided must be repaired or replaced for any reason during the second half of their design life, it is considered a replacement and under SSNP conservation offsets apply.

Entering Length and Width

Entering floats, boat ramps, and jetties into the Conservation Calculator generally requires input of length and width parameters, rather than simply square footage. In addition to impacts related to square footage of structure, these structures have a physical buffer with added impacts factored into the final credits/debits (based on Ono et al. 2010). To correctly determine buffers, the longer side of the structure should be entered into the length field, regardless of orientation. Exceptions for overwater structures spanning several zones are discussed in the *Tab 4: Overwater Structures* section.

Replacement vs. New

If the area of a replacement structure exceeds the area of the existing structure, the difference is considered to be new/expanded structure. This determination is made by structure type and shore zone.

> Example – If a replacement jetty is reduced in width but extended into the LSZ where there previously was no jetty, all area of the jetty in the LSZ is considered new/expanded.
>
> Example – If a boat ramp is replaced with a jetty, the jetty is considered to be a new structure.

A detailed discussion and more examples of expanded overwater structures can be found in section *Tab 4: Overwater Structures*.

Increased Credits for Removals with Site Protection

The time horizon for credit determination associated with structure removal and no site protection on the property (e.g., a deed restriction or conservation easement) is 10 years. However, the Conservation Calculator is set up to credit removals of structure where site protections are in place for time horizons longer than 10 years. If proposing structure removals with site protections following the USACE regulations, Components of a Mitigation Plan (4) site protections instrument 33 CFR 332.4(c) §332.7(a); specific for nearshore structures, the USACE informs on deed restrictions associated with compensatory mitigation here. Contact the Services for help determining credits. If you would like an immediate **estimate** of increased credits based on a site protection, you may use Entry Block II, on the appropriate tab. Enter the dimensions of the structure to be removed as though you were installing a replacement structure; the resulting negative credits reflect the positive credits you would receive for a 40-year (design life for overwater structures and boat ramps) easement.

For shoreline armor removal the Services credit easements for a time of up to 50 years (limit based on sea level rise). Please contact Services via PSNearshoreConservation.WCR@noaa.gov for help with determining increased credits for armor removal with easements following USACE regulation.

Submerged Aquatic Vegetation

1. Submerged aquatic vegetation (SAV) density informs habitat values in the Conservation Calculator. SAV surveys provide site-specific information that is used in most tabs in the Conservation Calculator.
2. Use the WDFW Eelgrass/Macroalgae Habitat Interim Survey Guidelines to conduct SAV surveys and follow the USACE "Components of a Complete Eelgrass Delineation Report" for eelgrass delineations. If surveys are conducted outside of the SAV survey window (June 1st - October 1st), NOAA may increase the SAV rating in the Conservation Calculator to account for the likely underestimate of SAV coverage outside of the main growing season. This decision depends on additional site-specific information like site specific growth patterns, temperature regime of the area, and WDFW area habitat biologist input, as available.
3. When a survey shows that no macroalgae and only eelgrass is present, we also accept an Eelgrass Delineation Report based on the Components of a Complete Eelgrass Delineation Report developed by Dr. Deborah Shafer Nelson, U.S. Army Engineer Research and Development Center; Special Public Notice May 27, 2016.
4. SAV determinations should be based on the average SAV density in the footprint of the structure including a 25-foot buffer around the structure.
5. For the determination of the SAV category based on SAV density use Table 1, which is also displayed in the Conservation Calculator reference tab.
6. SAV category determinations for replacements: For most small size replacement projects, SAV information can be provided without a new survey by using a combination of older SAV surveys, SAV surveys from adjacent properties, pictures at extreme low tides, information from Washington State Department of Ecology's (WDOE's) Coastal Atlas map, or information from WDFW biologists.
7. Structure removals with SAV have two options:
    a. Enter the SAV category based on the average cover density as outlined above in number 4.
    b. Enter the SAV category based on the average cover density of the 25-foot buffer surrounding the structure. This option is appropriate if there is a distinct difference between SAV cover under an overwater structure and the area around it and it is likely that the SAV will reestablish after the structure removal.
8. Credit for the removal of unpermitted structures in the nearshore will be approved on a case-by-case basis.

Delineation of Lower Shore Zone SAV Scenarios		
VEGETATION SCENARIO	***Native Eelgrass and/or Kelp occurs within 25 feet of project area***	***Other SAV occurs within 25 feet of project area (no native eelgrass or kelp present)***
Scenario 0	N/A	≤ 10%
Scenario 1	1-25% Combined SAV	11-25%
Scenario 2	26-69% Combined SAV	26-75%
Scenario 3	≥ 70% Combined SAV	> 75%
Delineation of Upper Shore Zone SAV Scenarios		
VEGETATION SCENARIO	***Macro algae and saltmarsh vegetation (such as Salicornia sp. and Distichlis sp.)***	
Scenario 0	Less than 5% of cover	
Scenario 1	Between >5% and < 30% of cover	
Scenario 2	Between >30% and <60% of cover	
Scenario 3	Between >30% and <60% of cover	

Table 1. Delineation of Lower Shore Zone and Upper Shore Zone SAV scenarios (categories). SAV is defined as rooted vascular plants and attached macroalgae. Drift algae and Ulva spp. are not included when determining cover percentage unless Ulva spp. occurs in documented herring spawning areas.

Credit/Debit Factors

For habitat conditions that are especially important for Puget Sound Chinook and Hood Canal summer-run chum, the final credits or debits are multiplied by a factor. The Conservation Calculator only applies these credit/debit factors to aspects of the project that would affect the important habitat condition. Table 2 shows how the credit/debit factors apply to certain project elements.

1. Major Estuary Zones: A map of Puget Sound Natal & Pocket Estuaries is available on the PS Nearshore web page. We are using the historical extent of PS Chinook salmon natal river deltas plus a 5-mile buffer (as the fish swims), as per the PS Chinook Salmon Recovery Plan nearshore chapter (Redman et al. June 2005). For Hood Canal summer-run chum, we are using a 1-mile buffer around natal rivers and rivers where re-introduction was successful based on the first priority level for recovery actions of the Hood Canal summer-run chum recovery plan (Brewer et al. 2005).
2. Pocket Estuary or Embayment: See the Puget Sound Natal & Pocket Estuaries map
3. Feeder Bluff: We currently use the WDOE Coastal Atlas map with coastal landforms data layer to determine the location of feeder bluffs.
4. Forage Fish Spawning: We rely on WDFW's Forage Fish Spawning map and surveys to determine presence and extent of Pacific herring, Pacific sand lance and surf smelt. If questions arise for a specific location, USACE, USFWS, or NOAA staff will clarify presence in consultation with WDFW.

5. Shoreline armoring that is located within the same drift cell and updrift of forage fish spawning habitat. Use the WDOE Coastal Atlas map to determine drift direction.

While the GIS layer for "Major Estuary Zones" and "Pocket Estuary or Embayment" is depicted as a band (this is an artifact of how the GIS layer was created), these landscape-scale credit/debit factors apply to all zones and the entire structure. In other words, if any part of a structure overlaps or is waterward of location that is mapped as either "Major Estuary Zones" and/or "Pocket Estuary or Embayment," this credit/debit factor applies to all parts of that structure not just the parts that are located on the band shown on the GIS layer; also see Table 2.

Nearshore Impact	Major Estuary Zone	Pocket Beach	Feeder Bluff	Sand lance or surf smelt spawning	Updrift of FF spawning within same drift cell	Herring spawning
Shoreline armoring	XX	XX	XX	XX	XX	In rare cases
Piers and ramps	XX	XX				
Piles depending on zone	XX	XX	XX	XX		XX
Floats (USZ)	XX	XX		XX	In rare cases	
Floats (LSZ)	XX	XX				XX
Floats (DZ)	XX	XX				depends
Creosote Piles WQ benefit[1]	X	X		x		x
Boat ramps & Jetties (USZ)	XX	XX	XX	XX	In rare cases	
Boat ramps & Jetties (LSZ)	XX	XX				XX
Boat ramps & Jetties (DZ)	XX	XX				
Beach Nourishment	XX	XX		XX	XX	
Riparian	XX	XX	XX	XX		

Table 2. Project-specific application of credit/debit factors. Credit/debit factors for water quality benefits related to creosote removal are 40% of full credit/debit factor because we expect creosote piles to be on site only for approximately 40 years of the 100-year assumed benefit period. After that they likely have broken off and are floating through Puget Sound.

Duplication of Tabs

The *Overwater Structure, MDredging, Beach N,* and *SAV Planting* tabs can be duplicated as many times as necessary in one Conservation Calculator workbook. This can be helpful for entering multiple structures on complex projects.

To duplicate one of these tabs, right click a tab on the bottom and click “Move or Copy.” Then select the tab to duplicate, check the box that reads “Create a Copy” on the bottom of the window, then press “Ok.”

The Conservation Calculator does not allow for duplication of *ShorelStab* or *BoatR, Jetty* tabs. For Excel experts, the *Overwater Structures, MDredging, Beach N,* and *SAV Planting* tabs work with lookup tables in the background, and the other tabs use the NHVM in the background. If an additional *ShorelStab* or *BoatR, Jetty* tab is needed for a complex project, please use and submit an additional Conservation Calculator workbook.

Important: Conservation credit/debit totals from duplicated tabs will not auto-populate in the summary tab, so the user should make a note about any added tabs and their resulting credit/debit outputs in the *ProjectD* tab. During consultation, NOAA project biologists will unlock and modify the *Summary* tab as needed.

Hiding Tabs

Tabs that are not in use can be hidden to make your calculator more user-friendly. Simply right click on the tab at the bottom and select "Hide." To unhide tabs, right click on any existing tab, click "Unhide" and select the tab to unhide.

Advanced users: For visual ease only, we have hidden the NHVM and HEA calculation tabs. These tabs are the gears that build and populate the user-friendly Conservation Calculator you see. Using the "unhide" method described here will allow you to get into the Conservation Calculator mechanics if you wish to dig deeper.

Puget Sound Conservation Calculator Tabs

The Conservation Calculator consists of different entry worksheets/tabs for different types of actions. The worksheets are:

1. Summary
2. ProjectD: For recording project specific details
3. RZ: Riparian Zone
4. Overwater structures
5. ShorelStab: Shoreline stabilization
6. InputShorel
7. MDredging: Maintenance Dredging
8. BoatR, Jetty: Boat ramps, Jetties, Rubble
9. BeachN: Beach Nourishment
10. SAV Planting
11. Ref.: References

The following sections describe different components of the Conservation Calculator and provide guidance for entering project information so that the outputs will be accurate and consistent.

Tab 1: Summary

A run-down of all impacts/benefits entered into the Conservation Calculator. This tab provides the total credits/debits consisting of the sum of all project elements.

Tab 2: ProjectD

The *ProjectD* tab is intended for recording project specific details relevant for filling out the Conservation Calculator. This is also the place to document your work and reference external sources you used to derive input values. For example, if you are using pictures at low tide to support your SAV category selection, add a note referencing the pictures and your conclusions or copy and paste the pictures into the *ProjectD* tab.

Tab 3: RZ (Riparian Zone)

Vegetation changes that occur within 130 feet of Highest Astronomical Tide (HAT) as part of a project are entered into the *RZ* tab. According to Brennan et al. (2009), various nearshore functions are supported by adjacent riparian habitat. They reviewed published literature, recommended buffers, and Forest Ecosystem Management Assessment Team (FEMAT) curves to evaluate each of these functions and propose different riparian buffer widths to maintain a minimum 80% effective function. NOAA considered the information provided in this review and designated the area within 40 meters above HAT as the riparian area for the Conservation Calculator. This width is focused on supporting shade, large woody debris recruitment, litter/organic matter inputs, water quality, and habitat function which we believe are the most impactful for aquatic ESA listed species in the region.

Square footage is entered in a **before and after** scenario in columns E and G. The key to entry is that the total square footage input into column E (before) must equal the total square footage in column G (after). Changes are represented in four categories (in Rows 14 through 17): Trees, Shrubs, Herbaceous Vegetation, and Impervious/Unvegetated. Entry represents the “changes” to the riparian from one habitat category to another.

Riparian categories are represented in the *RZ* tab with highest ecological value on top, descending to the lowest. Trees are on top, down to impervious surface/unvegetated on the bottom. A shift of square footage from impervious (in before column E) to trees (in after column G) would represent the most habitat benefit.

There may be locations in which woody vegetation growth extends below HAT, especially in areas with stabilized shorelines. In those locations, the area where woody vegetation is planted for mitigation may be entered in this tab, including any areas below HAT.

Riparian enhancements can be evaluated with the RZ tab/worksheet regardless of location as long as they are located within the same service area as the impact site.

Submit a planting plan, performance standards, proposed monitoring plans, and site protection if applicable with your consultation initiation package. You can find an example of a mitigation plan at: Components of a Mitigation Plan (4) site protections instrument; information on deed restrictions associated with compensatory mitigation here; and an example of a Mitigation Monitoring Report for riparian plantings can be found here.

Overstory and Understory
Ideally, native plantings should provide overstory *and* understory conditions. For overstory and understory arrangements, only the square footage of total area is entered into the Conservation Calculator – in other words, square footage cannot be "double counted" for two categories. Instead, enter the square footage as represented by the highest habitat value. For example, if trees are planted with native herbaceous vegetation below, enter only the square footage associated with the trees in the "After" column. Additional credit for shrubs or herbaceous vegetation under trees is not given.

Entering Trees and Shrubs
Enter trees and shrubs into the "After" column of the *RZ* tab as their full/mature crown size (area in square feet as seen from above), rather than the size when planted. The HEA model has time built into these categories and accounts for additional years needed for woody plants to reach their full size.

To find mature tree crown square footage, please use the Washington State University's PNW Plants website.

1) On the PNW plants website, find the "Width" of the tree on the right hand "Plant Characteristics" box
2) Divide the width in half to obtain the radius of the tree crown
3) Use the formula for area of the circle $A = \pi r^2$ where A is the area (the total crown square footage as seen from above), π is pi (3.14159), and r is the radius obtained in #2 above.

Note: Only use plants native to the area and appropriate for the weather and salt water conditions.

Tab 4: Overwater Structures
The Conservation Calculator allows for determining the impact of overwater structures (OWS) including simple piers, ramps, floats, and other structures that shade nearshore habitats. Entering measurements for typical piers, ramps, and floats into the calculator is straightforward, whereas entering measurements for more complex structures, like marinas and industrial structures, may require more explanation which is provided below.

Simple Float Entry
Enter the length and width of a simple float in the respective shore zone and grating category (solid or grated). Also see "Entering Length and Width" in the *General Information* section. Unlike piers and ramps, floats have associated buffers. In order to allow the Conservation Calculator to correctly determine the buffer area of the float, the length and width must be considered. Always enter the longer side of a float into the length field, regardless of orientation.

> Example – For a replacement 8 feet by 30 feet 50% grated float with 70% open space in the LSZ, in the Overwater Structures tab, enter 30 in cell 57E, and 8 in cell 58E.

In order to be entered as a grated float, floats *must* have at least 50% functional grating, with a minimum of 60% open space (consistent with WAC 220-660-140).

Covered boat slips are entered into the nearshore Conservation Calculator as solid floats.

Simple Floats with Length and Width Spanning Two or More Shore Zones

If a float extends across more than one shore zone, the width entity must be adjusted to avoid double-counting a portion of the buffer. To do this:

1) Enter the float dimensions (L and W) for the portion of the float located in the more landward shore zone. Enter these zone-specific dimensions in the yellow entry cells for length and width.
2) For the adjoining waterward zone(s), enter only the length (in that zone) into the yellow entry field, **leaving the width at 0**. Then, manually enter the area (in square feet) for the applicable nearshore zone in the pink square footage box.

Example – For replacement of a grated float spanning the LSZ and DSZ, manually enter the float DSZ area located in the DSZ in the pink entry cell E63.[11] Then enter the total DSZ length into the yellow entry cell E59, and enter 0 into E60.

Because other overwater structures, such as piers and ramps, do not have buffers, this modification is not needed for those structures extending across shore zones.

Complex Floats

Floats can have several "branches" or float components contributing to their overall shape. Enter T-shaped floats, L-shaped floats, comb-shaped floats, and other irregular-shaped floats into the Conservation Calculator as complex floats.

Complex Floats with One Type of Decking

Floats with decking that is entirely grated or entirely solid can be entered as a "complex float" following these two steps.

1) Enter the total length and the width at the widest point into the appropriate nearshore zone (LSZ, or DSZ) and grating category (solid or grated). This will allow for calculations of a simplified overall float buffer.
2) Determine the area of the complex float and manually enter the square footage directly into the appropriate pink[12] nearshore zone's cell. Letting the calculator determine the square footage for complex floats results in an overestimate of the total area, as it simply multiplies length by width.

[11] The Conservation Calculator determines a buffer for floats based on length and width. If a float spans two zones, entering length and width for all zones would result in an additional buffer area based on the width at the zone break. The above outlined entry method ensures correct buffer determination in that no buffer area is assigned to the width at the end of a zone.

[12] Most entry cells in the Conservation Calculator are yellow. This is one of the few cases where an area is manually entered into the pink float area cell.

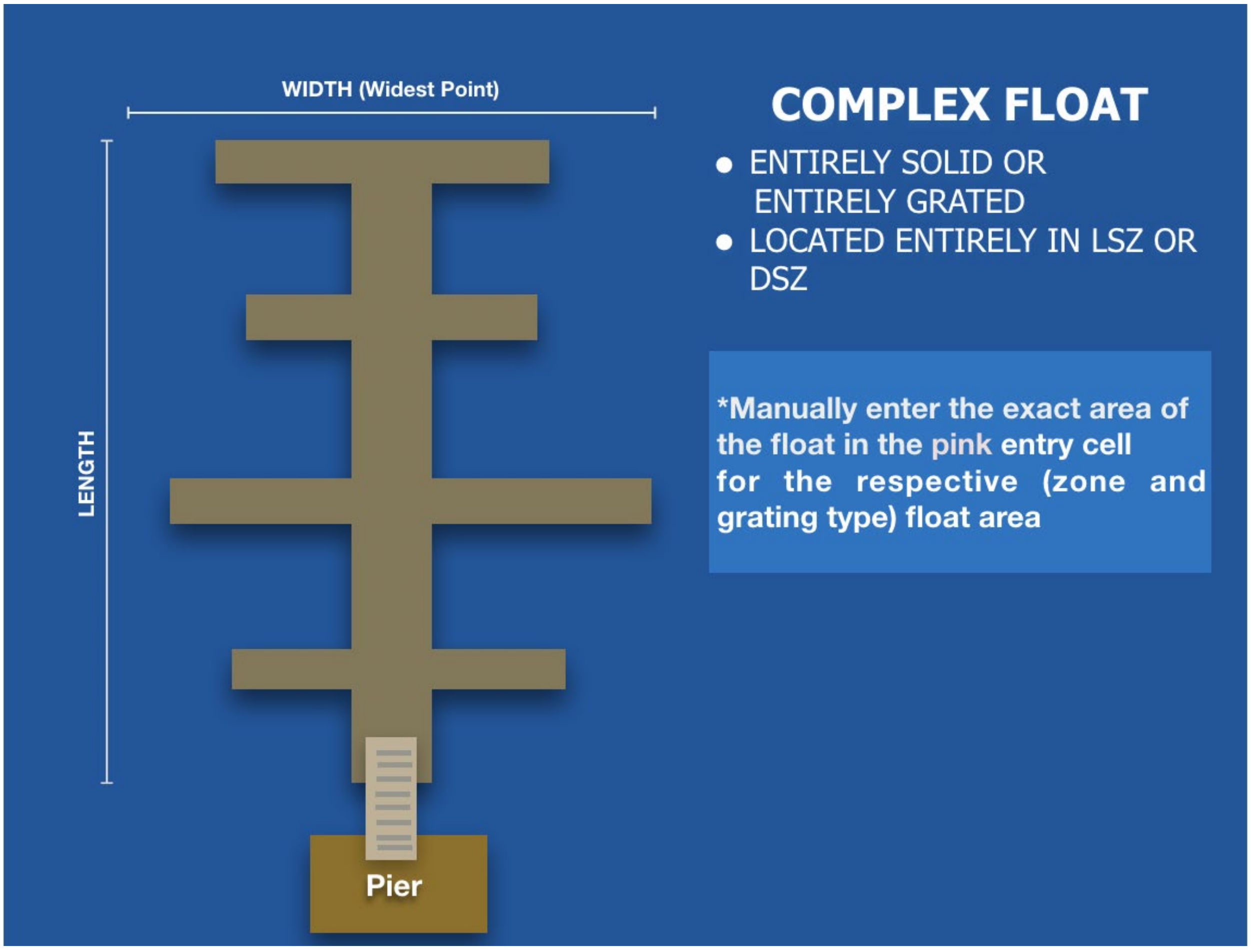


Figure 6. Complex Float with One Type of Decking located entirely in either the LSZ or DSZ.

Complex Floats with Solid Walkways and Grated Finger Slips

Some commercial and marina floats have a combination of solid and grated floats. Since there are different float types (solid and grated) within one structure, entry must be split between the solid and grated areas of the Conservation Calculator.

When a complex float structure has a solid center "walkway" and grated fingers, enter it in the Conservation Calculator in the following way:

1) Enter the solid main walkway as a simple solid float (as outlined above under *Simple Float Entry*: Enter the longest dimension in the length entry field and the shortest in the width entry field.)

   Example – For a replacement structure in the LSZ, enter length into cell E66 and width into E67.

2) Under grated float:
   a. Enter the widest width of the entire complex float minus the center walkway as the width (the length of the longest finger floats on both sides of the center

walkway, not including the center walkway. In Figure 8: W1+W2). Leave the length at 0.

b. Manually enter the total square footage of the grated finger floats directly into the pink square foot field.

54			Enter average diameter of piles in DZ.	[inches]	0	0.00
55	Grated Float to be Installed	Enter the outside dimensions of replacement floats with at least 50% grating and 60% or more open space as grated floats (Compliant with WAC 220-660-140). For simplicity and as we expect floats to meet state regulations, grated floats are not split between grated and ungrated portions. For complex floats, enter the longest outside dimensions of the float. See Example Complex Float 1.	USZ Outside dimensions of replacement float.	Length [feet]	0	Enter length and width of floats for buffer determination. For complex floats, enter the sum of the length of each float and the widest width of the floats. See User Guide for more isntructions. **Set length and width to 0 for zones where no structure present.**
56				Width [feet]	0	
57			LSZ Outside dimensions of replacement float.	Length [feet]	0	
58				Width [feet]	60	
59			DZ Outside dimensions of replacement float.	Length [feet]	0	
60				Width [feet]	0	Reference: Complex Floats
61		The area of the float in each respective shore zone is calculated from length and width entered above. For irregularly shaped floats, user should directly enter the square footage of the float in the appropriate zone (see Notes for more information on irregularly shaped floats). BMP: Floats should not be located in the USZ and cannot ground out.	Grated Float USZ	SqFt	0	**0.00**
62			Grated Float LSZ	SqFt	960	**-46.78**
63			Grated Float DZ	SqFt	0	**0.00**
64	Solid Float to be Installed	Solid float have higher adverse effects on the nearshore environment compared to grated floats. We highly encourage applicants to grate overwater structures as much as possible. Because of the higher impacts from solid floats compared to grated floats, resulting conservation debits are higher. Enter the length and width of the float in the appropriate shore zone (see Table 2). For complex floats, enter longest outside dimensions of float. See Example Complex Float 1	USZ Outside dimensions of replacement float.	Length [feet]	0	Enter length and width of floats for buffer determination. For complex floats, enter the sum of the length of each float and the widest width of the floats. See User Guide for more isntructions. **Set length and width to 0 for zones where no structure present.**
65				Width [feet]	0	
66			LSZ Outside dimensions of replacement float.	Length [feet]	80	
67				Width [feet]	10	
68			DZ Outside dimensions of replacement float.	Length [feet]	0	
69				Width [feet]	0	Reference: Complex Floats
70		The area of a float is calculated by shore zone from the length and width entered above. For irregularly shaped floats, enter the square footage of the float in the appropriate zone (see Notes for more information on irregularly shaped floats). BMP: Floats should not be located in the USZ and cannot ground out.	Solid Float USZ	SqFt	0	**0.00**
71			Solid Float LSZ	SqFt	800	**-72.30**
72			Solid Float DZ	SqFt	0	**0.00**

Figure 7. Example Entries for a Replacement Complex Float with two types of decking (solid walkway and grated finger slips) in the LSZ.

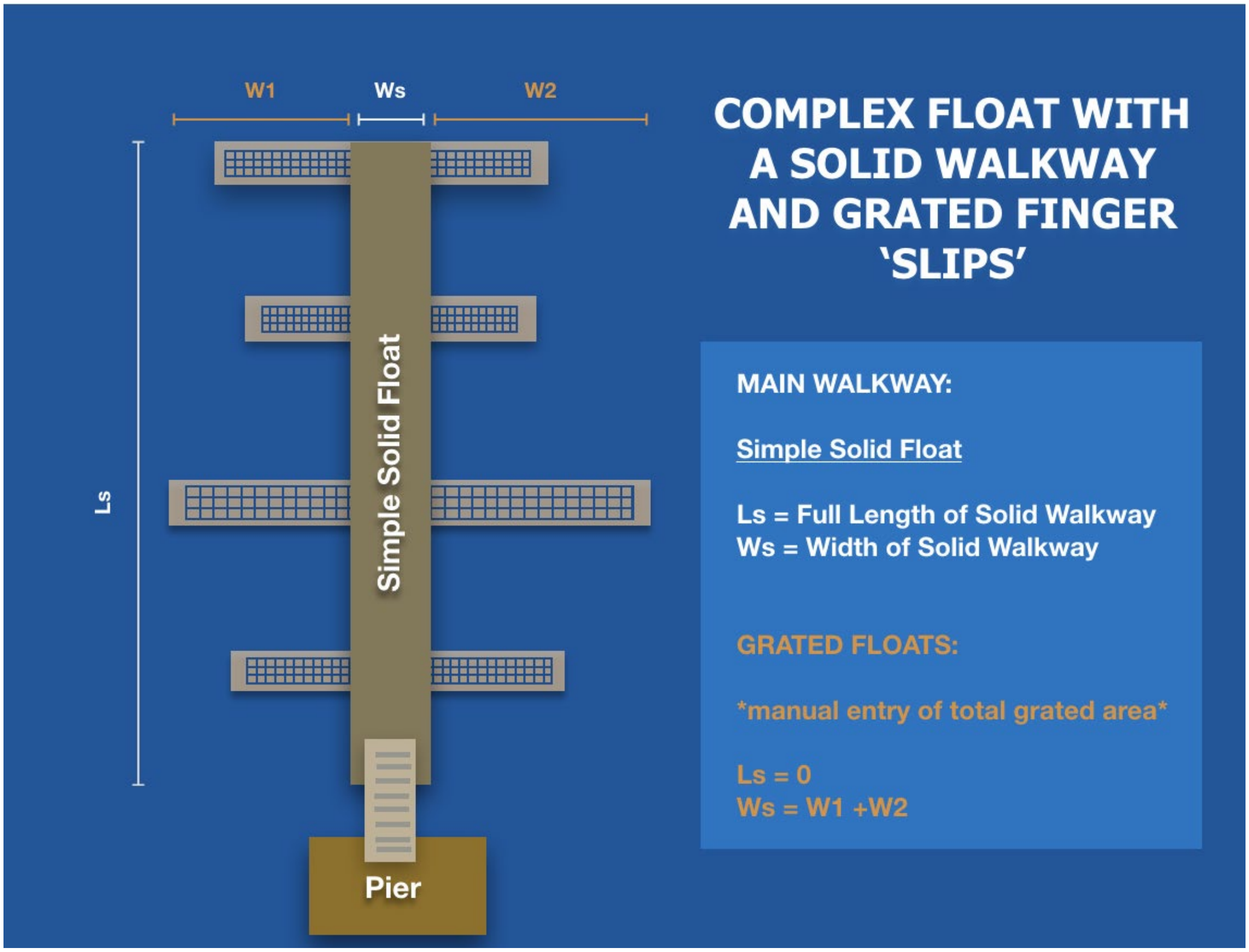


Figure 8. Complex Float with Two Types of Decking (grated finger slips and a solid walkway) located entirely in either the LSZ or DSZ.

Complex Floats Spanning Two or Three Shore Zones

When complex floats extend across several nearshore zones (Figure 9), the float area as well as length and width entries for buffer calculations must be zone specific. To enter complex floats in more than one shore zone:

1) Enter the length of the complex float portion that exists in the most landward shore zone in the yellow entry field for its corresponding shore zone. Length, in this case, represents a portion of the longest dimension as it spans all shore zones.
2) Enter the maximum width of all the floats together (finger floats and walkways) in the yellow entry field for width in the most landward shore zone.
3) Manually enter the area of the float portion located in the most landward shore zone in the pink field for square footage.
4) For the adjoining waterward zone(s), enter the total zone-specific length into the yellow entry field for float length. Manually enter a width of 0.

5) Manually enter the area of the float located in each waterward shore zone into the respective pink field for square footage.

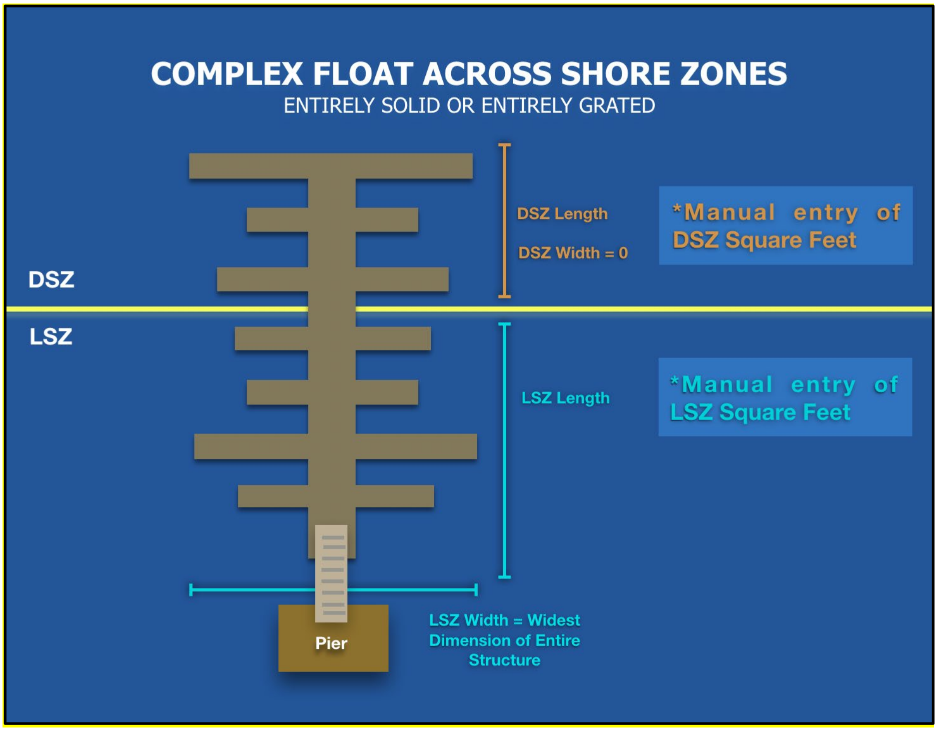


Figure 9. Complex Float with One Type of Decking (either solid or grated) extending across Multiple Shore Zone.

Conservation Calculator entry instructions for complex floats spanning two or three shore zones with both grated and solid decking combine the approaches outlined above under *Complex Floats with Solid Walkways and Grated Finger Slips* and *Complex Floats Spanning Two or Three Shore Zones*:

1) Enter the length of the complex float portion in the most landward shore zone in the yellow entry field for length of a *solid* float in its corresponding shore zone. Length, in this case, represents a portion of the longest dimension as it spans all shore zones, LSZ L1 in Figure 9.
2) Enter the longest width of *all* the floats together (e.g., finger floats and walkways) in the yellow entry field for width of a *grated* float in the most landward shore zone, LSZ W1 in Figure 8.
3) Enter 0 for the remaining landward shore zone dimension fields (solid float width and grated float length).
4) Manually enter the square footage of the solid portion of the float in the landward shore zone in the pink field for solid square footage. And manually enter the square footage of

the grated potion of the float in the landward shore zone in the pink field for grated square footage.

5) For the adjoining waterward zone(s), enter the total zone-specific length into the yellow entry field for the length of a **solid float,** DSZ L2 in Figure 9. Manually enter a width of 0. Manually enter the square footage for both the grated square footage and solid square footage for the total waterward shore zone of the float.

Replacement vs. New Overwater Structures[13]

If the area of a replacement overwater structure is larger than the area of the removed structure (Figure 10), the difference is entered in the Conservation Calculator as new or expanded overwater coverage. The area entry for an expanded structure will be split between Entry Blocks I: New/Expanded area and Entry Blocks II: Replacement area and must be entered in the respective nearshore zone.

The Conservation Calculator determines impacts/benefits based on the affected area *in each shore zone*. Thus, the determination of what is new or expanded coverage is zone specific. Exception for legacy structures[14]: Replacing floats in the USZ with same size floats in the LSZ can be entered as a replacement.

Finally, to enter a structure element as a replacement, it must be a "like structure." Like structures are those that would be entered into the same structure category in the Conservation Calculator. For example, piers and ramps are like structures. Grated floats, solid floats and pontoons are also like structures.

Typically, the same square footage in the same zone can be minimally realigned. However, large shifts in location that cause increased habitat impacts should be entered as new structures (e.g., if a replacement pier is shifted 50 feet from its original location, and/or to an area with more SAV).

[13] The "New" category also applies to the ShorelStab and BoatR, Jetty tabs (Tabs 5 and 7 respectively). In these tabs it is a drop down "yes" or "no" selection, rather than a separate entry block.

[14] New and replacement floats are usually not placed in the USZ where the water depth is insufficient to prevent the structure from grounding out on the substrate during normal low tides.

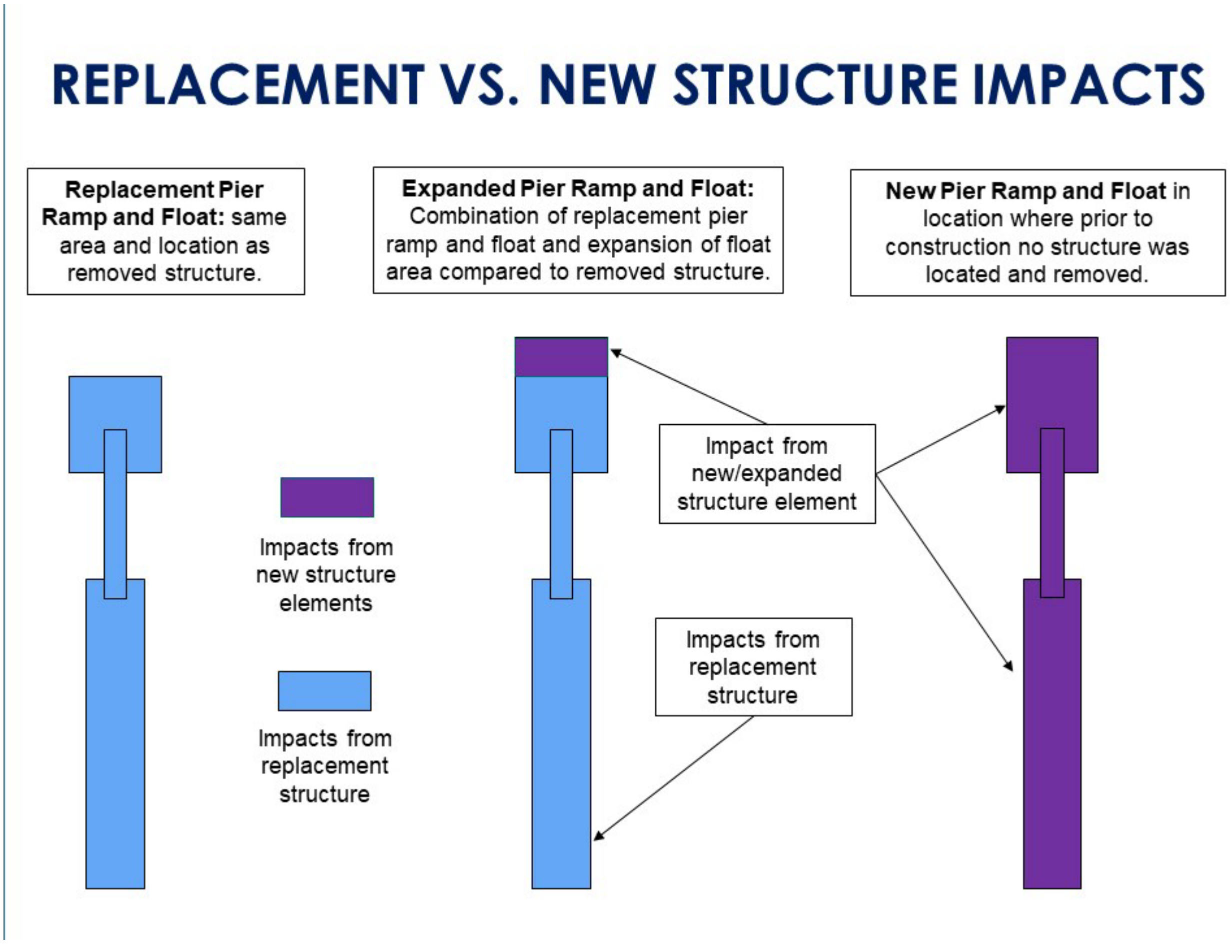


Figure 10. Replacement versus New/Expanded Structure Impacts

Entering Replacements with Expansions in the Calculator:

1. Confirm the total square footage of each like structure category to be removed within each shore zone. This is your maximum replacement square footage. Enter this in Entry Block III.
2. Enter the total square footage for the replacement structures in Entry Block II. This area must not exceed the values for zone specific areas entered above in Entry Block III.
3. Excess "replacement" structure square footage exceeding the removal square footage within a shore zone are considered expansions and must be placed in Entry Block I: New/Expanded. Enter zone specific expansions for each like structure in Entry Block I. Exception for legacy structures[15]: Replacing floats in the USZ with same size floats in the LSZ can be entered as a replacement.

[15] New and replacement floats are usually not placed in the USZ where water depth is insufficient to prevent the structure from grounding out on substrate during normal low flow or low tide conditions.

We refer to area and square footage in the above section to focus on the concept of what is considered new/expanded area. To enter the area in the Conservation Calculator, this requires in most cases determining relevant length and width. As discussed with floats spanning different shore zones, the entry of float dimensions for expanded floats also has to consider the buffer area and is explained below.

Example – When removing a 5x10 foot solid float from the LSZ and installing a 5x5 foot grated float with a 3x3 foot solid mooring buoy in the LSZ:

- The total removal square footage in LSZ = 50 square feet. Enter 50 square feet solid float into the Removal Entry Block, along with the dimensions of the float.
- The total replacement square footage in LSZ = 25 + 9 = 34 square feet, which is less than the original 50 square feet. Therefore, both of these structures are entered in the Replace Entry Block. Even though the new float is grated (not solid) and the mooring buoy is "new," the square footage from Remove is applied to the Replace section because the float and mooring buoy are "like structures." The Replace structures are still entered as a 5x5 grated float and a 3x3 solid float in different entry boxes.

Length and Width Entry for Expanded Floats

This section covers directions for entering the length and width for replacement floats with expansions accounting for the buffer around floats. Enter the replaced square footage of the float with the actual Length and Width in Entry Block II. Enter the New/Expansion portion in Entry Block I, manually enter the square footage in the pink entry filed, enter the expanded length, and leave the width entry field at 0. This allows for the buffer area to match the new dimensions.

Example – For a 30x8 foot grated float being replaced with a 40x8 foot grated float in the LSZ (50% grated, > 60% open space) (Figure 11):

- In the Entry Block for replacement structures, enter 30 and 8 as the length and width respectively.
- In the Entry Block for new structures, enter 10 for the length of the "new/expanded" float, leave the width as 0, and enter 80 square feet as the area of the new/expanded float.

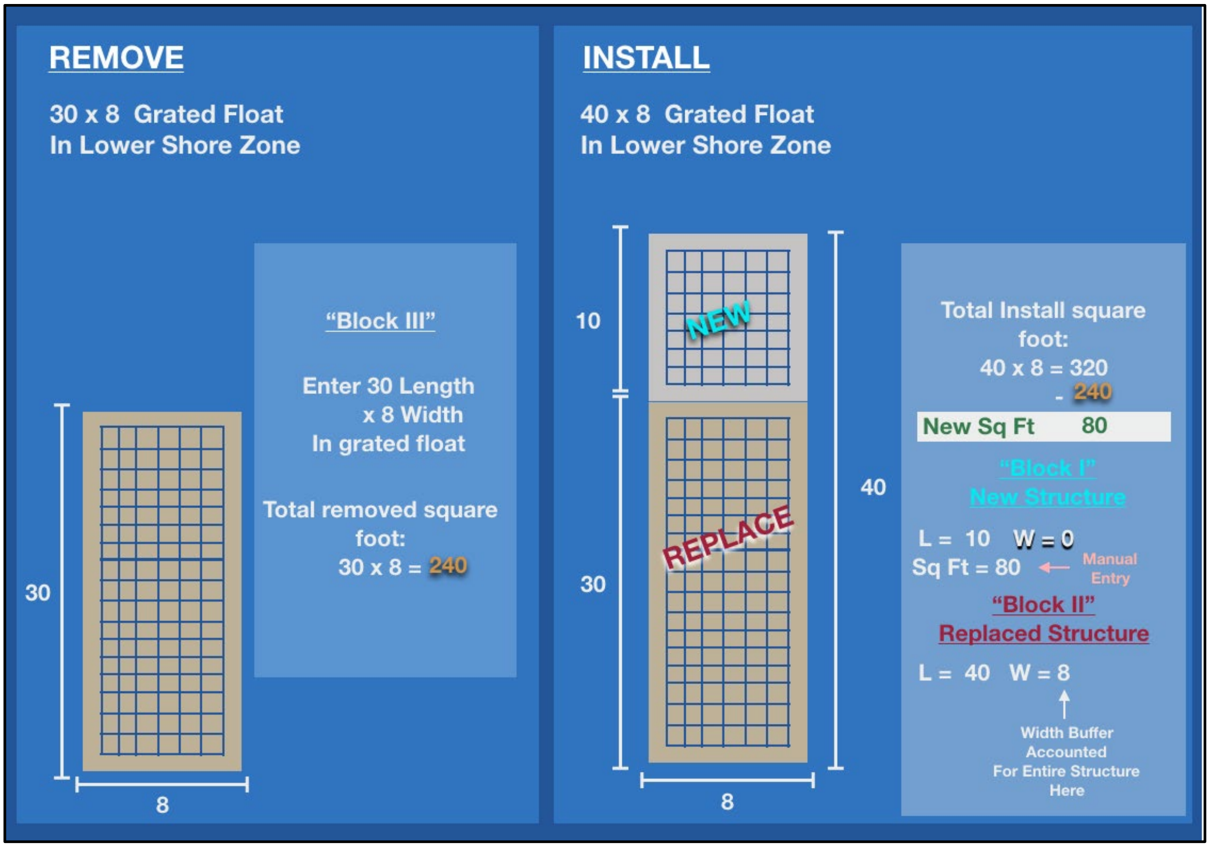


Figure 11. Example Visualization of Replacement Float: Above example where a 30x8 foot grated float is being replaced with a 40x8 foot grated float in the LSZ.

Mooring Buoys

In general, when a mooring buoy reduces or prevents ongoing adverse impacts, mooring buoys do not need to be entered into the Conservation Calculator. This applies in situations where vessels are currently moored in areas where they have adverse impacts and would without the placement of a new mooring buoy likely continue to be moored and have negative impacts. This includes situations where mooring buoys would re-direct vessel moorage away from areas where vessels ground out, or where vessels impact dense SAV (SAV score 2 or more), or areas with any kelp, or any eelgrass. In such cases, the applicant should provide information and evidence of ongoing adverse effects and their reduction based on the placement of the mooring buoys.

Otherwise, mooring buoys act similar to and should be entered into the Conservation Calculator as simple solid floats. Enter the length and width into the yellow entry fields.

The situations where mooring buoys should not be entered into the Conservation Calculator are limited to scenarios where the benefits from indirect effects of the mooring buoys[16] that are

[16] Benefits from placement of mooring buoys include redirecting shading associated with vessels away from areas with SAV to areas with less or no SAV and redirecting vessels from areas where they ground out and create sediment disturbance.

otherwise not considered in the Conservation Calculator outweigh the adverse effects from the placement of the mooring buoy. While adverse effects from boats on critical habitat need to be addressed in ESA Section 7 consultations, the Conservation Calculator currently does not assign debits from boats. If, however, unregulated adverse effects from boats exist, are ongoing, and would be reduced by the placement of mooring buoys, the mooring buoys do not have to be entered in the Conservation Calculator as impacting structures.

Large Solid Decks/Piers

Generally, elevated decks and piers have a smaller impact than floats because side lighting reduces the amount of shading. However, the wider a deck is, the less effective the side lighting compared to a long and narrow deck (e.g., a pier). In wide decks, much of the center of the deck is not affected by side lighting because light does not reach under the center of a wide deck (Figure 12).

To account for the dark center on wide decks, enter the deck area within 20 feet from the edge as a pier, and enter the remaining center deck area more than 20 feet from the edge as a float; enter the float area directly into the pink entry cell for solid floats.

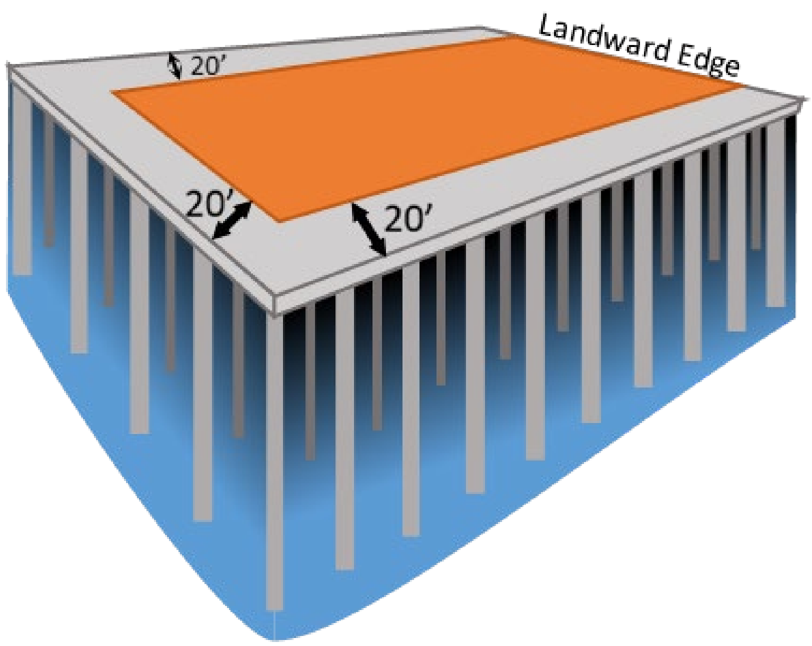


Figure 12. Conservation Calculator Entry for Large Solid Decks. Use two different entry zones: The orange center represents the area of a solid deck that is entered as a float due to the lack of light penetration from the sides. The 20 feet gray area is entered as an elevated solid deck. The blue gradient shows how the lighting dims towards the center underneath a large deck.

Houseboats and other 3-dimensional Overwater Structures

Three-dimensional structures, including net sheds and houseboats, create a larger shadow than flat decks. To account for the larger shadow, add half of the square footage of the largest shade producing vertical wall to the area of solid overwater coverage derived from the horizontal coverage (Figure 13).

1) Enter the length and width (Y and X in Figure 13 below) into the yellow entry fields for solid floats.
2) Manually enter the total shade producing area into the pink area entry field for the applicable nearshore zone. The total shade producing area is = X*Y + ½(A*B).

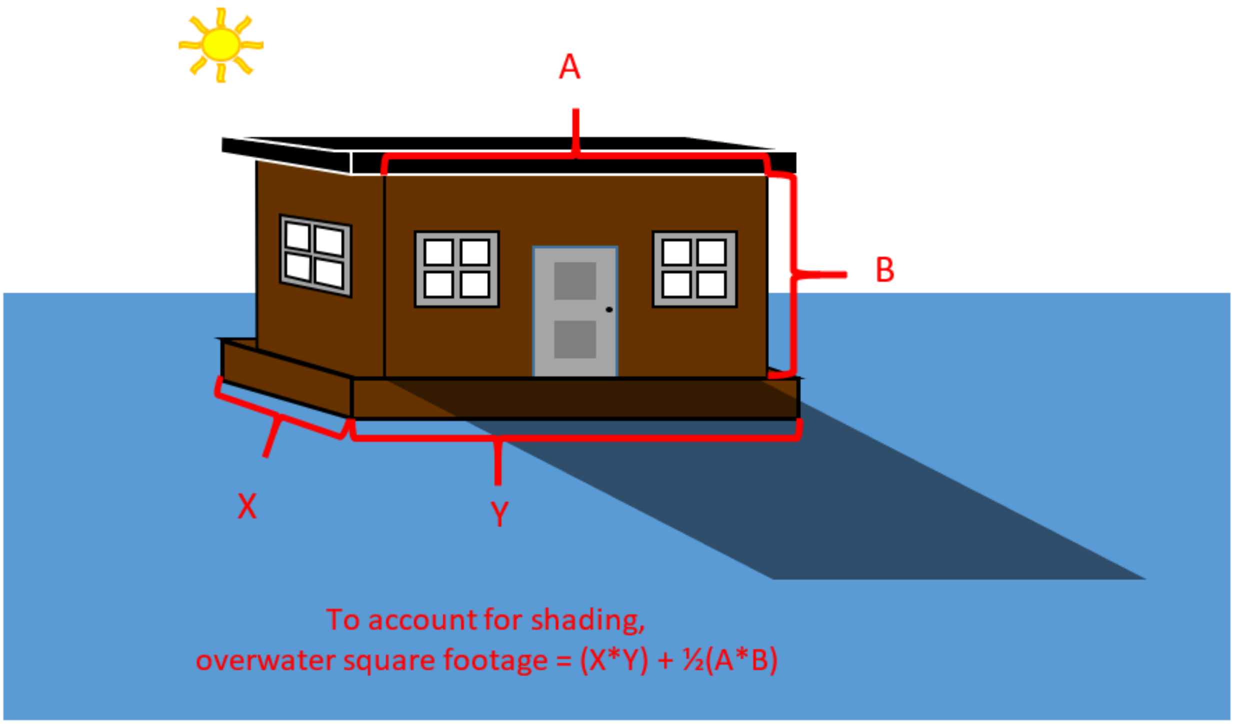


Figure 13. Houseboats: Three-dimensional Overwater Structure. For Conservation Calculator entry, include height for determining the total shade producing area.

Boat Lifts

Boat lifts are generally entered as solid or grated piers. If the boatlift is covered, the covered area between the pontoons should be entered as a solid pier. Uncovered boat lifts are entered as grated piers. Dimensions of boats (even if stored in the lift) are not entered into the Conservation Calculator. Piles associated with boat lifts are entered as piles.

Pontoons integrated within lifts that are permanently in contact with water should be entered as a complex float (see complex float entry above). Enter the longest length and width of both pontoons as the dimensions, then manually enter the pontoon area (Figure 14).

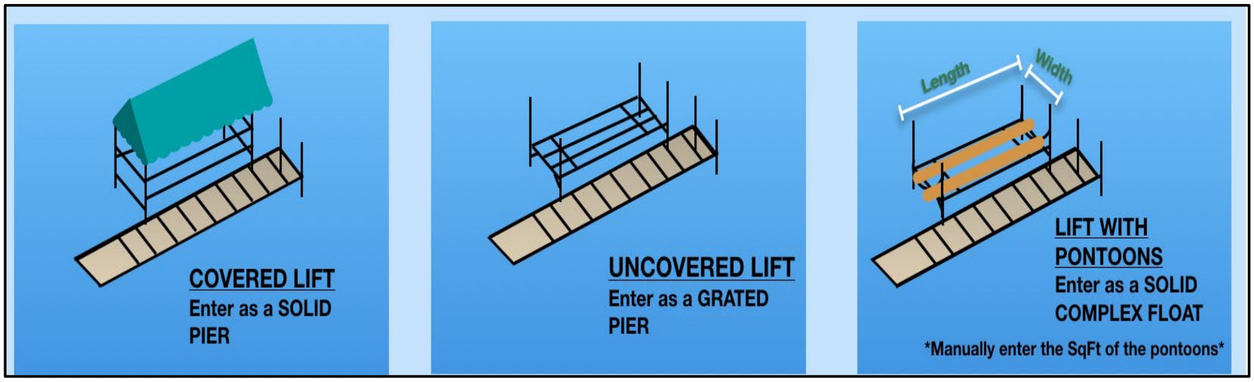


Figure 14. Different Types of Boat Lifts.

Repair and Replacement of Overwater Structures

Overlapping Structural Elements: Overwater structures contain overlapping structural elements like float tubes and decking. As debits/credits are based on area impacts, only the element with the largest area should be entered. Use the examples below to inform entries for similar situations.

1. Repairs to the float structural components, such as the frame and stringers: Enter 100% of the float square footage into the calculator (solid or grated surface as applicable) to determine impacts. If float tubes are replaced at same time, no extra entry is required for float tubes (no double offsets).
2. If decking on a float is proposed to be replaced, enter the area of the decking unless:
   a. Within the last 20 years (first half the design life of a float) the frame and stringers, or decking have been replaced and conservation debits were provided for the entire float or proposed to be replaced element.
   b. Solid well-functioning decking is being replaced with grated decking (see below).

To quantify impacts from repairs and partial replacements with the Conservation Calculator:

1. Enter the footprint as determined using the principles above into Overwater Entry Block for Removal, Removal as Part of Replacements, and Repair.
2. Enter the footprint of the replaced/repaired structure element (proposed), in the Overwater Entry Block for Repair and Replacement. If the footprint of the replaced/repaired structure exceeds the footprint of the existing structure, you need to enter the expanded footprint as new/expanded area, see Figure 10.

Replacement of Well-Functioning Solid Decking with Fully Grated Decking for the Purpose of Reducing Shading

If well-functioning solid decking on overwater structures (floats, ramps, and piers) is proposed to be replaced with fully grated decking (defined as a minimum of 60% open space, in compliance with WAC 220-660-140), the decking replacement does not have to be entered into the calculator[17] if **all** of the following conditions are met:

1. The solid decking being replaced is in well-functioning condition with a remaining functional life of more than 10 years (dated photos of existing decking must be provided). If any solid surface on the overwater structure is proposed to be replaced with new solid surface decking, then this condition would not be met. In that case, both grated and solid replacement decking must be entered into the Conservation Calculator because the replacement of the solid surface with solid surface suggests the decking was approaching the end of its design life and needed to be replaced. For example, if solid decking is proposed to be replaced with decking that has a "grated, solid, grated" pattern and all decking is replaced, then all decking replacement and removal would be entered in the Conservation Calculator.
2. Decking replacement aims at reducing adverse effects from shading rather than extending the life of the structure.[18] For example, state and local agencies or tribal entities often ask applicants to replace well-functioning solid decking with grated decking to reduce impacts. Such replacements would not have to be entered into the Conservation Calculator if conditions 1 and 3 in this description are also met.
3. No other structural replacements on the subject structure beyond decking are proposed. If other replacements or upgrades (like the replacement of piles, frame, stringers or float tubes) are proposed at time of the decking replacement, or within the 10 years following the decking replacement, all elements must be entered into the Conservation Calculator. The rationale is that the replacement of other elements at the same time or within 10 years suggests that at the time of decking replacement condition (#1 above) was not met and the structure, including the solid decking, had no more than 10 years of remaining functional life left.

   If an applicant proposes to replace additional components of an overwater structure within ten years of replacing the solid decking, the evaluation of the later-proposed project would likely need to consider the long-term impacts of the previously replaced decking. In other words, the completed solid decking replacement will have to be entered into the Conservation Calculator along with the proposed project at the time of the later replacement.

   Example – If the upgrade of an old float includes the replacement of solid decking with grated decking along with replacement of a float tube, then all elements are entered in the Conservation Calculator.

[17] If the decking replacement is not entered into the Conservation Calculator, there will be no removal credit for the removal of the solid decking. This is based on the fact that the removal credit for solid decking with a remaining life of approximately 30 years is about equal to the placement of the same area of grated decking with a design life of 40 years.

[18] Expected remaining life is more than 10 years.

Example – If a float that had its solid decking replaced under this provision and proposes nine years later to replace a different float element, the replaced decking has to be considered retroactively as the replacement of other float elements suggests that the float including the solid decking had less than 10 years of remaining life left and did not meet the conditions above.

Piles

This section outlines specifics regarding entering different types of piles into the *Overwater Structures* tab of the Conservation Calculator.

1) Structural piles excluding batter piles, or fender piles: (a) entering the number of piles to be placed, replaced or repaired and (b) entering the diameter of piles.
2) Multiple pile sizes: If different pile sizes are being installed, enter the average diameter of all the piles. A quick-use calculator provided in the *Overwater Structures* tab at row 129 allows for easy determination of the average pile diameter for each nearshore zone.
3) Batter piles and fender piles: Enter installation of new but not replacement piles. This is a simplified approach to account for the frequent replacement of non-structural piles intended to be hit by vessels.
4) Creosote removal: Residential creosote piles usually weigh ½ a ton or less rather than the 1 ton for industrial-sized, 70-ft-long piles. Use the tonnage estimator provided in the *Overwater Structures* tab at row 154 to determine the weight of creosote treated wood piles for known length and average diameter. Long wood piles often vary in diameter between top and bottom. Use average pile diameter for weight estimation.
5) Monitoring/Reporting of Creosote removal: After creosote removal and upland disposal, applicants must submit the disposal receipts and a picture of the dump truck on the scale to the Services. Disposal receipts need to contain actual weight of the total removed creosote. **Estimated credit calculations may require adjustment if the estimated creosote removal weight is greater or less than the actual disposed quantity.** The Services may use the average difference between estimated and actual creosote removal quantities over a year as an adjustment factor for the following year. In other words, if year one estimates were on average 8% higher than actual disposal quantities, then all estimated creosote removal quantities may be automatically discounted by 8% in year two.
6) Pile Repair: Pile repair (including adding sleeves/jackets) extends the life of a pile just like a replacement. Thus, enter the numbers of repaired piles including their increased diameter (example below) along with replaced piles. Removal credit applies to repairing piles.

    Example – Pile jacketing increases the diameter of piles. Enter the average pile diameter for partially jacketed piles and the number of to-be-repaired piles in Entry Block II: Repair and Replace of Overwater Structure Elements. Also enter the number of to-be-repaired piles and existing diameter of the old piles in Entry Block III: Removal. In terms of effects to habitat, repairs and replacements are similar and thus treated the same in the Conservation Calculator.

If creosote piles are repaired, enter only the weight of creosote treated wood that is proposed to be removed in the entry cell for ”tons of creosote to be removed.” If strut repair is proposed, usually the bottom section of the creosote pile remains in place.

Crediting/Debiting Factors for OWS

As described in the *General Information Applicable to Most Tabs: Credit/Debit Factors* section below, effects to habitat features that are especially important to Puget Sound Chinook and Hood Canal summer-run chum are multiplied by a factor. This gives more weight to the impact/credit of a proposed action on these especially important habitats. New in Conservation Calculator V 1.4, crediting/debiting factors can be entered in the ProjectD tab. They are applicable to the entire project. If a project consists of different locations that required application of different credit/debit factors, please fill out one Conservation Calculator per project location. We found that in Conservation Calculator V 1.3, applicants rarely used the separate entry blocks for credit/debit factors that allows for the installation of a new structure and the removal of an existing structure to be at different locations.

Floats in the DSZ in herring spawning and holding areas may have a herring factor applied depending on site conditions. The application of the herring spawning & holding factor to OWS in the DSZ is based on the consulting biologist’s and WDFW’s assessment of impacts related to the proximity of structure to holding and spawning areas, the size, type, and configuration of the proposed structure, and frequency and duration of use of the affected area.

Tab 5: ShorelStab (Shoreline Stabilization)

Hard Armoring

Shoreline armoring results in reducing the available nearshore habitat landward of hard armoring. Hard armoring cuts off access to the shallow nearshore area that is preferred early marine rearing habitat for juvenile PS Chinook salmon. This is called **intertidal encroachment** and is depicted in Figure 15. Intertidal encroachment encompasses the area between the toe of armoring and the HAT. Critical habitat for PS Chinook salmon is listed under the ESA up to the HAT (50 CFR 226.212). Hard shoreline armoring can also reduce the habitat quality waterward of the hard armoring via adverse effects. Such adverse effects include reducing wrack and large wood accumulation (and thus food availability for juvenile salmonids, also known as habitat provision), changing the wave regime (wave reflection), coarsening substrate, and lowering the beach profile (Figure 16) (Dethier et al. 2016a; Dethier et al. 2016b; Heerhartz et al. 2014; Heerhartz et al. 2016; Prosser et al. 2018). The Conservation Calculator evaluates these impacts to intertidal critical habitat for ESA-listed PS Chinook and Hood Canal summer-run chum salmon via an area based functional assessment. It evaluates the respective functional loss for the area of the intertidal encroachment and for a standard area waterward of armoring. Most functional loss occurs via intertidal encroachment.

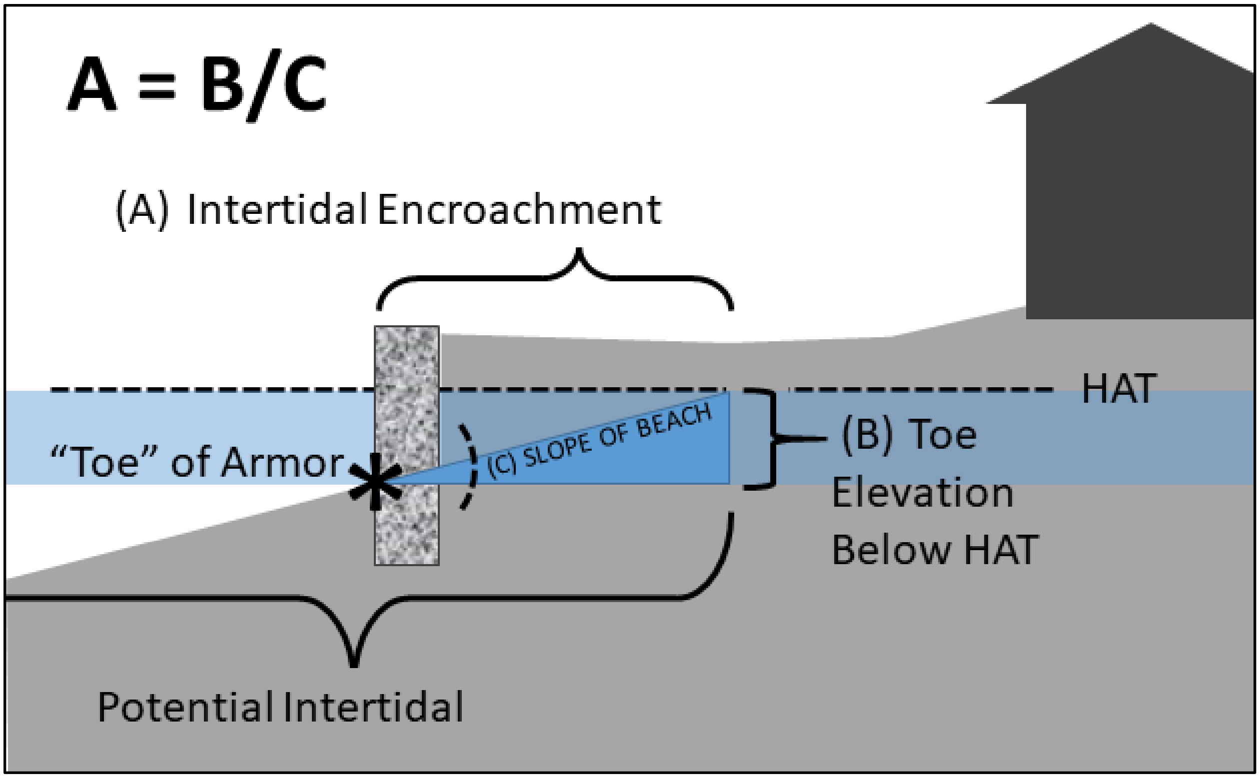


Figure 15. Intertidal encroachment. Figure designed by Paul Cereghino.

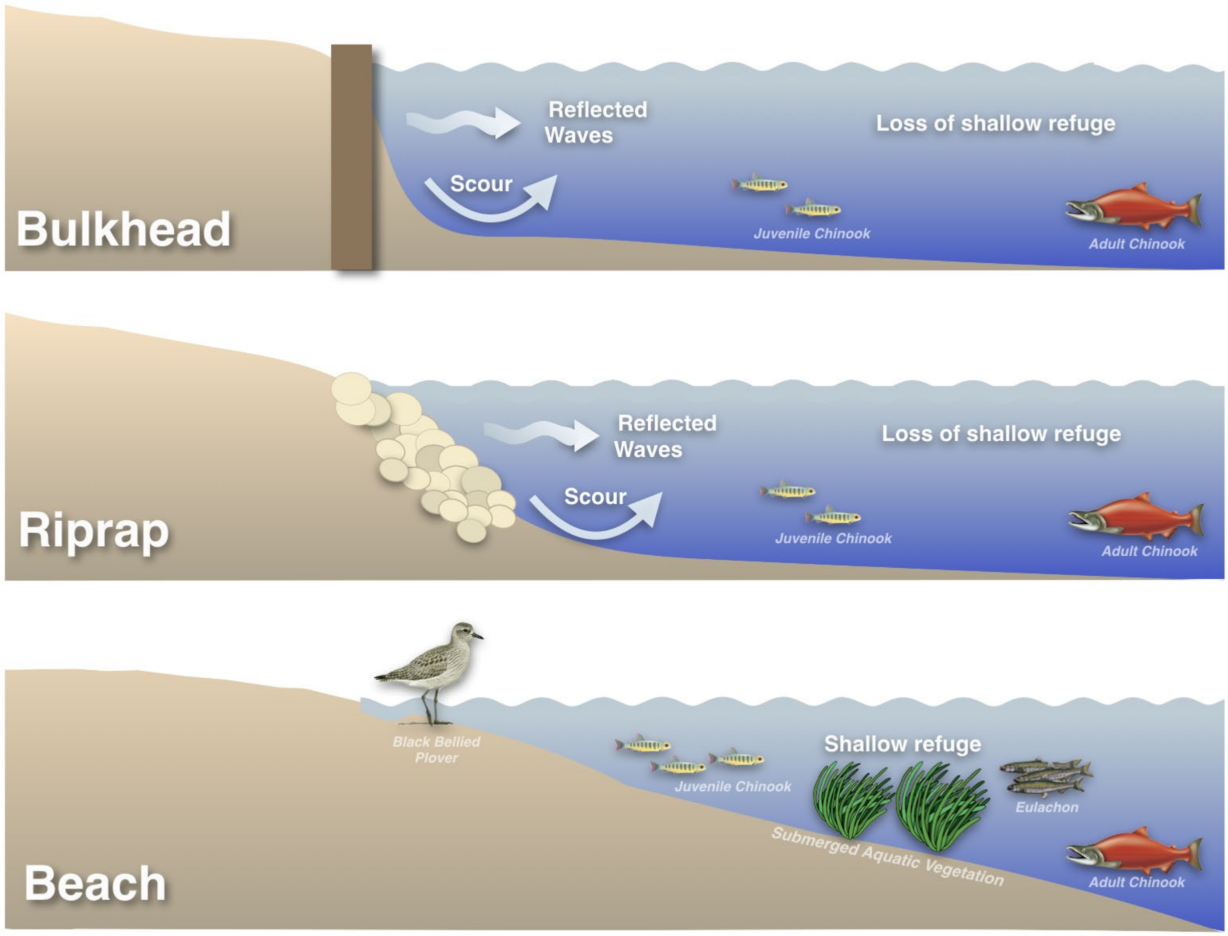


Figure 16. Effects of hard shoreline armoring adapted from Prosser et al. 2018.

The Conservation Calculator determines the area of intertidal encroachment considering the following three factors:

1. The length of the armoring
2. The location (elevation) of the toe of armoring relative to Mean Higher High Water (MHHW), and
3. The distance between MHHW and HAT

For the first factor, the length of armoring paralleling the shoreline should be taken from design plans. At times, armoring may wrap into the upland or encircle features jutting out into the intertidal. For such situations, the length relevant for the Conservation Calculator is the length parallel to the shoreline, only. Also see Figure 17.

Figure 17: Determination of Length of Shoreline Stabilization.

The second factor, the elevation of the toe of armoring[19] relative to MHHW, also is taken from design drawings. If no survey information is available to determine the elevation of the toe of hard armoring, follow the instructions in the *Toe of Armoring Relative to MHHW* section on page 50 of this guide for approximating the toe elevation.

To determine the third piece of information necessary for calculating the affected area, the distance between MHHW and HAT, NOAA recently developed an approach. We document this approach in more detail in Cereghino et al. (2022) (NOAA White Paper *in draft*). In short, NOAA developed tidal contour lines for the entire Puget Sound region outlining MHHW and HAT. We used NOAA tidal datum model outputs and a USGS high-resolution topobathymetric digital elevation model. These tidal contour lines provide site-specific elevations. Tidal contour lines are currently available on NOAAs GIS server at https://noaa.maps.arcgis.com/home/item.html?id=69c1c16ba7c8473d890e9eaed9fc6d4f#visualize.

We used the horizontal distance between MHHW and HAT based on typical beach slopes rather than measuring site specific distances in the GIS layer. Reasons include that determining site-

[19] The toe of a bulkhead, for the purpose of Conservation Calculator entry, is where the sand or other beach substrate naturally meets the bulkhead, not at the deepest portion of the bulkhead (extending below the beach grade).

specific horizontal distances between MHHW and HAT is subject to errors related to limited resolution (1 meter for recent USGS CoNED 2020 data), low confidence of the method at beaches with steep slopes, inter-annual beach profile variability, and finally that site-specific distances between MHHW and HAT cannot consistently be determined at hydromodified sites.[20] To reduce errors, NOAA developed typical average beach slope values for unarmored beaches stratified by marine basin and beach type (Table 3). NOAA used the beach types described by MacLennan et al. 2017. In the Conservation Calculator, these typical beach slopes can then be used in combination with the site-specific elevations for MHHW and HAT taken from the GIS contour elevation lines to derive the site-specific distance between MHHW and HAT. NOAA documents the results from this approach in *Tab 5: InputShorel* of the Conservation Calculator.

The formulaic expression of the horizontal distance between MHHW and HAT is:

> *Horizontal Distance (HAT - MHHW) = (site specific: HAT elevation – MHHW elevation)/typical slope (taken from Table 3).*

The horizontal distance between MHHW and HAT is determined by a Service biologist on the *InputShorel* tab. The result will be entered by a Service biologist in cell C32 of the *ShorelStab* tab.

Typical Stratified Beach Slopes				
Basin/Service Area	**Beach Type**	**Slope (rise over run)**	**Percent Slope ***	**Degrees ****
Hood Canal	Accretion	0.142	14.2	8.1
Hood Canal	Feeder Bluff	0.28	28	15.6
Hood Canal	FB Exceptional	0.17	17	9.7
Hood Canal	Transport	0.287	28.7	16
North Puget Sound	Accretion	0.191	19.1	10.8
North Puget Sound	Feeder Bluff	0.177	17.7	10
North Puget Sound	FB Exceptional	0.176	17.6	10

[20] Hydromodified sites are sites where the beach profile has been altered by structures, for example existing bulkheads.

Typical Stratified Beach Slopes				
North Puget Sound	Transport	0.799	79.9	38.6
South Central Puget Sound	Accretion	0.134	13.4	7.6
South Central Puget Sound	Feeder Bluff	0.316	31.6	17.5
South Central Puget Sound	FB Exceptional	0.26	26	14.6
South Central Puget Sound	Transport	0.295	29.5	16.4
Strait of Juan de Fuca	Accretion	0.126	12.6	7.18
Strait of Juan de Fuca	Feeder Bluff	0.177	17.7	10.04
Strait of Juan de Fuca	FB Exceptional	0.12	12	6.8
Strait of Juan de Fuca	Transport	0.24	24	
Whidbey	Accretion	0.143	14.3	
Whidbey	Feeder Bluff	0.243	24.3	
Whidbey	FB Exceptional	0.241	24.1	
Whidbey	Transport	0.262	26.2	

Table 3. Typical stratified beach slopes by marine basin, beach type, and their slopes. This table is included in the ProjectD tab of the Conservation Calculator.

* *What is a 25% slope?* A 25 % slope is simply a ratio of 25:100. In other words, the ground rises 2.5 inches every 10 inches of horizontal distance.

** *How does percent slope relate to degrees?* A 100% slope corresponds to 45 degrees. Convert the slope percentage to a ratio (slope (rise over run)) and look up the ratio in a tangent table

Additional notes:

- See NOAA's Nearshore Conservation Calculator webpage for basin/service areas map.
- For sites at hydromodified locations, use adjacent beach types.
- For sites with "no appreciable drift," err on the side of the species and use the lowest slope value for that basin. Such sites (unless misclassified) often do not need armoring; instead, consider a hybrid approach.

Soft and Hybrid Bank Stabilization

Placement of soft or hybrid bank stabilization currently does not incur debits as it mostly allows aquatic access across the elements of stabilization. Replacing hard armoring with soft or hybrid approaches can result in conservation credits. Soft and hybrid armoring are defined below.

Soft Shoreline Treatments - Soft shore approaches allow for the following functions:

- Connectivity between terrestrial and aquatic habitats
- Natural fine sediment transport or accretion rates (i.e., does not coarsen the substrate)
- Does not inhibit sediment transport from upslope sources
- Retains native vegetation
- Supports forage fish spawning
- Does not increase erosion on the project beach or on adjacent properties
- Does not cause lowering of beach elevation
- Allows for woody debris and wrack to accumulate

Criteria for soft shore approaches:

1. No, or minimal, use of artificial structural elements
2. Incorporate beach nourishment (sand and small gravel)
3. Incorporate riparian plantings or allow for recruitment of native vegetation, including overhanging vegetation
4. Incorporate or allow for large wood recruitment, including allowances for small toe erosion protection where necessary, but where the wood does not act as a berm or a crib.
5. Large wood may be chained as part of the design.
6. Boulders may be incorporated into the design, but must not be used as a primary slope stabilizing element.
7. Degradable fabric and support filters may be used but must be designed and constructed to prevent surface exposure of the material through time.
8. Cannot not resemble a wall in any respect

Hybrid Shoreline Treatments – Hybrid shore approaches allow for the following functions:

- The hybrid method itself does not inhibit sediment transport from upslope sources (e.g., an adjacent road that is not part of the project may inhibit sediment transport that would not reflect on the hybrid technique).
- Retains native vegetation
- Supports forage fish spawning
- Does not increase erosion on the project beach or on adjacent properties
- Minimizes lowering of beach elevation
- Allows for woody debris and wrack to accumulate

Criteria for hybrid approaches:

1. Contains artificial structure that allows for some biological processes to occur (such as forage fish spawning), but inhibits some ecological processes from fully occurring (such

as suppressing some sediment transport, supply or accretion, but not fully ceasing the process as with hardened approaches).

2. Exposed rock, if used, must be discontinuously placed on the beach (i.e., not act as a berm or scour sediments)
3. For any individual project, a hybrid approach may not contain more than 30% of exposed rock as measured against the length of the project beach.
4. Buried rock may be used below grade where necessary to stabilize the toe of the slope, but must not form a wall or resemble rip rap, and must be covered with sand/small gravel mixes in such a way to minimize net erosion through time.
5. Incorporate beach nourishment (sand and small gravel) as needed to minimize lowering of beach grade and net erosion.

Repair of Shoreline Armoring

If shoreline armoring is repaired in place, treat it the same as a replacement:

1. Fill in the metrics for replacement armoring in Entry Block I: Armoring to be Installed
2. Click "yes" for replacement
3. Fill in the metrics of the armoring to be repaired in Entry Block II

If a shoreline armoring repair does not remove the old structure but places a replacement structure waterward of the existing armoring or encases the existing structure with material to extend the life of the structure, proceed as explained above. However, reflect the new impact footprint in the slope distance in Entry Block I: Armoring to be Installed.

Repairs involving creosote: When repairing structures that contain creosote, creosote removal credit applies only to removed quantities of creosote.

COMMON QUESTION: When does removal of an existing bulkhead (BH) generate credit?

1. As with all structures that are proposed to be removed, removal credit[21] is tied to the structure being in good condition. For a bulkhead, that means the area landward of the structure is cut off from tides and aquatic access, preventing natural processes from occurring and aquatic use of that habitat.
2. Creosote bulkhead remnants that no longer function as a bulkhead anymore should be entered into the Conservation Calculator as creosote removal only. See Figure 17 and Figure 18 for examples of non-functioning bulkheads that would not be considered in good condition.
3. Concrete bulkhead remnants that no longer function as a bulkhead should be entered into the Conservation Calculator as rubble removal only.

[21] For a standard remaining life of 10 years.

Figure 18. Removal Credits for Old Creosote Bulkhead: Removal credit applied for creosote, not for remnants of bulkhead. Picture by and with permission from Doris Small, WDFW.

Figure 19. Removal Credits for Non-Functional Shoreline Armoring that is not in good condition. Removal credits do not apply for horizontal pile stabilizer as there is no functioning bulkhead effect (like sediment retention behind the bulkhead or elimination of water exchange).

Site Conditions Landward of Hard Armoring

This section assesses the value of the riparian habitat rendered inaccessible to fish via armoring. The inputs in cells C5-C7 are used to determine the area weighted habitat value of the riparian habitat after installation (new or replacement) of armoring. If just one habitat type is present, it is sufficient to enter a 1 into the respective row. If there is a 50% split of the area between two habitat types, enter a 1 into each row for respective habitat types. For more complicated scenarios, enter respective Square Foot for each habitat type.

For armor installation, the conditions described need to match the *after* conditions in the *RZ* tab (column G) if any changes in the RZ are proposed. Evaluate habitat improvement/degradation through actions like tree or shrub plantings separately in the RZ spreadsheet/tab.

For standalone shoreline armor removal projects, describe the before RZ conditions in cells C5 through C6. Armor removal is also entered in the *RZ* tab as a change from before = armored to after = unarmored in Row 21. The reverse is also true.

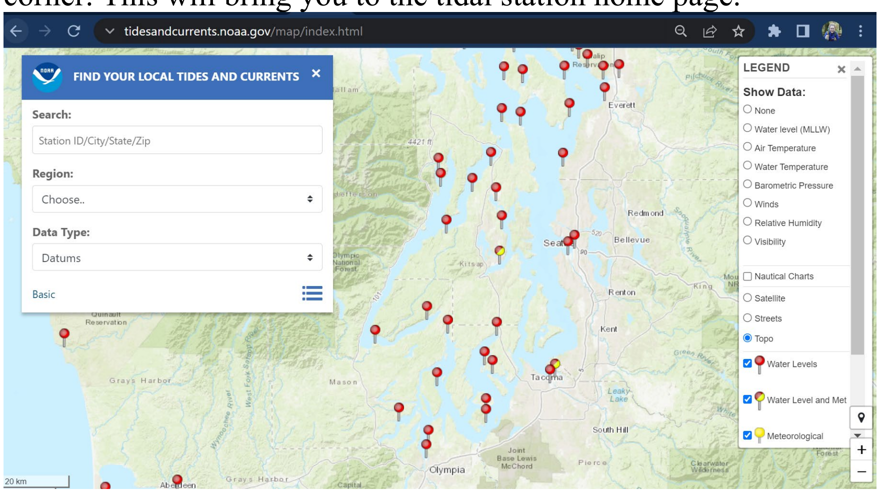
Toe of Armoring Relative to MHHW

This entry is needed for *Tab 5: ShorelStab* cells C15, C16 and C30, C31.

Toe of Bulkheads: The toe of a bulkhead, for the purpose of entry into the Conservation Calculator, is where the sand or other beach substrate naturally meets the bulkhead, at grade. Often, we receive bulkhead replacement project packages where MHHW is not known or shown on a cross section of a bulkhead.

The following steps can be taken for bulkheads where the elevation of MHHW is not known or documented at the site:

1) <u>If a beach survey is available</u>: Use the beach survey to determine whether the toe of the armoring is located above or below MHHW (cell C 15 and C 30). Then determine how much the toe of armoring is located above or below MHHW (cell C 16 and C 31). If the distance between the toe of armoring and MHHW water varies along the armoring, calculate a length weighted average and document your determination in *Tab 2: ProjectD.*
2) <u>If no beach survey is available</u>: We realize that surveys are costly and noticed that many armor replacement projects do not provide information on the toe elevation. This is our currently best draft approach to determining the toe elevation absent a survey. We appreciate your feedback and improvement suggestions.
    a. **Locate the nearest tidal station to the project** in the NOAA <u>Tides and Currents map</u>. On the search bar, click "Advanced," and under "Data Type" select "Datums." On the map, click on the red location marker that is closest (by water) to your project site. The maker symbolizes a NOAA tidal station with tide predictions and datums. An information box for that station will open. In the information box click on the "Station Home" drop down menu in the upper right corner. This will bring you to the tidal station home page.



    b. On the top of the station home page, click on the "Tides/Water Levels" drop down and click on "Datums." This will open a page showing tidal data for this station. **Record the MHHW value** shown towards the top of the elevations list. All data values are relative to the Mean Lower Low Water (MLLW). Note - some tidal stations do not have a "Datums" page. If this is the case, go back to the station map and locate the next closest tidal station.
    c. From there, go back up to the "Tides/Water Levels" drop down menu at the top of the page and click on "NOAA Tide Predictions." This will open a page showing tidal predictions for the station. Using the chart's date options, **locate days when a high tide (either the high tide or higher high tide) is near (within 0.1 foot) of the MHHW value** recorded in step b.
        i. You can click the blue button "plot calendar" on the bottom right to show an entire month of high and low tides.

    ii. Hover your mouse over a high tide that is within 0.1 ft of the Datum MHHW value to find out the exact time that high tide will occur. Take a screenshot or your result.
    iii. Alternatively, you can find a high tide within 0.1 ft of MHHW using the Data Listing below the graphic.

d. At the bulkhead site, take clear photographs within 10 minutes of the high tide time as determined above (where high tide is within 0.1 ft of the MHHW for the closest NOAA Tide Predictions station). Photos need to show:
    i. The water in relation to the bulkhead as viewed from multiple angles and along the entire existing bulkhead, at multiple photo locations.
    ii. Have a date, time, and GPS stamp. (Free smartphone apps can create this stamp see "Timestamp Camera Enterprise" for iPhone or android)
    iii. Include an object for scale reference (such as a 5-gallon bucket).
    iv. <u>For armoring above MHHW:</u> Lay out a tape measure from the water line landward to the bulkhead toe to determine the distance between the toe of armoring and the water. Take photos of the tape measure documenting this distance. If the distance between the toe and the waterline varies across the length, take several pictures and develop an area weighted average distance. Enter that distance in cell C 31 and/or C 16 depending on whether this is a replacement or new installation.
    v. <u>For armoring below MHHW:</u> Hold a tape measure showing the vertical distance between the toe of armoring and the water level. If you can't find or see the toe of the armoring (this can be challenging with rip-rap) use a marker to mark where the water level was at high tide and take a picture with a date stamp showing the mark at high tide. At low tide, take a second picture identifying the vertical distance between the MHHW line and the toe of the bulkhead. Use the appropriate slope from Table 3 (*Tab 6: InputShorel*) to determine the horizontal distance between the toe of the armoring and MHHW. Enter that distance in cell C 31 and/or C 16 depending on whether this is a replacement or new installation.

e. We would greatly appreciate it if you can take the time and submit distance determinations from two separate days. We are still in the test phase for this method and are trying to evaluate possible variability between different dates.
f. Submit these photos in an email along with the NWS and WCRO project number and which tidal reference station was used to the NOAA project biologist or PSNearshoreConservation.WCR@noaa.gov.
g. A NOAA biologist will review the submitted information and will update the Nearshore Conservation Calculator (if applicable). The biologist may also request additional information.

Tab 6: InputShorel

This tab supports entries for *Tab 5: ShorelStab*. It is designed to determine the horizontal distances between MHHW and HAT and between MHHW and the toe of armoring in feet.

To determine the **horizontal distance between MHHW and HAT**:

1. Open NOAA's Beach Slope Reference Line GIS layer located at: https://noaa.maps.arcgis.com/home/item.html?id=69c1c16ba7c8473d890e9eaed9fc6d4f#visualize.
2. Locate your project site and click on the reference line to open the information box.
3. Copy the MHHW and HAT elevations in feet from the information box (see Figure 20) into cells B6 and C6 in the *InputShorel* tab.
4. Using the Marine Basin Name and Shoretype_Beach from the information box, go to the the *InputShorel* tab to find the appropriate slope value in column K of the Typical Stratified Beach Slopes table.
5. In the *InputShorel* tab, enter or link the slope value from column K into cell D6. You can either type the slope value directly into cell D6, or link cell D6 to the applicable beach slope cell. For example, for a Hood Canal Accretion beach type you would enter "=K3" into cell D6.
6. Sea level rise was determined for three distinct areas: The Strait of Juan de Fuca, North Puget Sound, and a combination of South Central Puget Sound, Whidbey, and Hood Canal marine basins. No additional entries are needed for inclusion of sea level rise.

The site appropriate horizontal distance between MHHW and HAT in feet is calculated and displayed in E6 on the *InputShorel* tab. It is automatically copied into cells C17 and C32 in the *ShorelStab* tab.

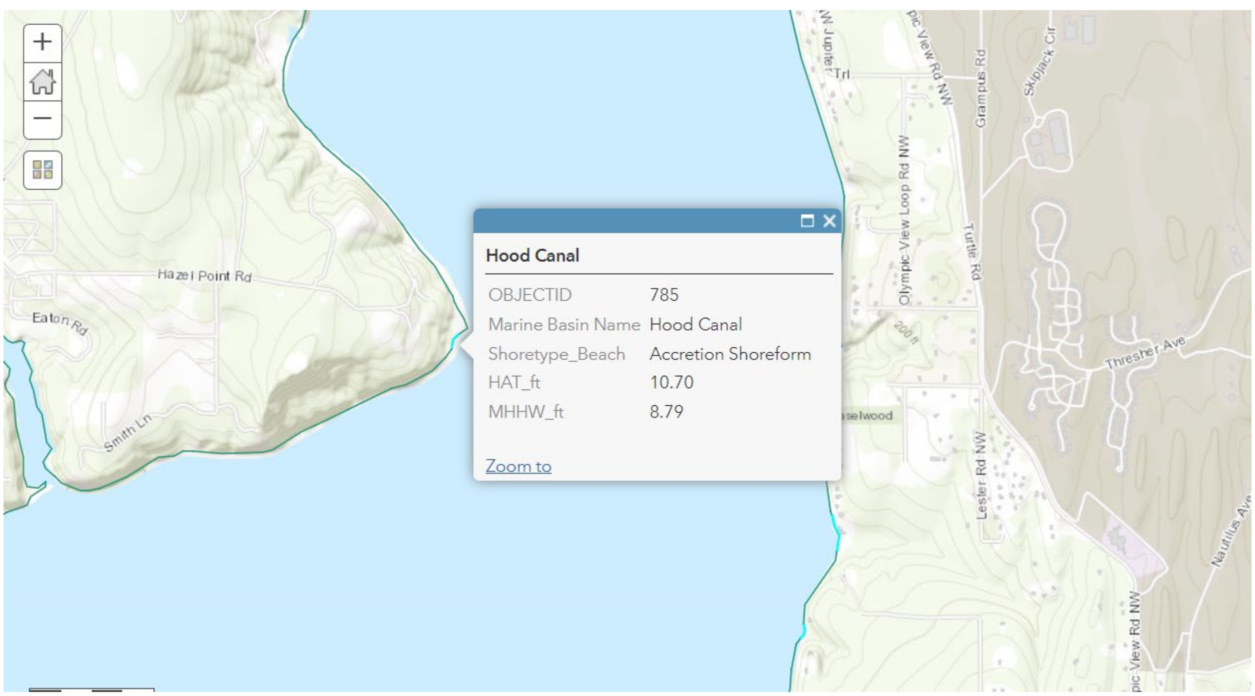


Figure 20. Beach Slope Reference Line Information Box.

Horizontal Distances between MHHW and the toe of armoring can be determined in row 15 for installation and row 19 for removal of armoring. The only needed entry is the vertical distance between MHHW and the toe of the bulkhead which is to be entered in the yellow entry cells B/C10 and B/C14. Site-specific typical beach slopes are automatically copied over from cell D6. The resulting horizontal distance between MHHW and the toe of armoring is automatically copied over into the *ShoreStab* tab.

Sea Level Rise

Climate Change will cause varying levels of sea level rise in Puget Sound. Sea level rise will cause bulkheads to cut off increasing areas of intertidal habitat from aquatic access. Sea level rise at sites with bulkheads means that the water level will move up on the bulkhead; MHHW and HAT will be higher on the beach while the toe of the BH remains in the same location. Effectively, sea level rise lowers the elevation of the toe of the armoring.

The Conservation Calculator includes the effect of average sea level rise for hard armoring for three distinct areas: the Strait of Juan de Fuca, the North Puget Sound marine basin, and the remaining three basins combined (*Tab 5: InputShoreI* rows 25 through 29). We chose this breakout based on geographic distribution of basin average rise projections.

- We used a middle of the road (50% exceedance probability) for the sea level rise prediction scenario.
- We used a low Representative Concentrations Pathways (RCP 4.5) greenhouse gas scenario
- We used the sea level rise scenario for 2050 as that is commonly available. This, again, will provide a rather low estimate as it uses a time horizon below the design life of a bulkhead (50 years).
- Including sea level rise predictions for 2050 as though they would occur now provides a conservative estimate because in HEA habitat now is more valuable than habitat in 40 years.

Fill Waterward of an Existing Bulkhead

Replacement/addition of fill (like rip-rap, rocks, ecology blocks) waterward of an existing bulkhead should be entered into the Conservation Calculator as a jetty with dimensions equal to the birds-eye-view length and width (and/or square footage) of habitat covered by the fill.

However, depending on the site-specific scenario, the NOAA biologist will evaluate whether the amount and type of fill is functioning as a new bulkhead. In that case, the new fill may be entered as a bulkhead.

Materials Added to the Toe of an Existing Bulkhead

If new material, such as logs or concrete, is permanently affixed to the toe of an existing bulkhead (to prevent scour or otherwise protect an existing bulkhead), the footprint of that material is entered into the Conservation Calculator in the *BoatR, Jetty* tab as “concrete footings” (‘No’ in cell E10) in the Boat Ramp Installation block. Dimensions entered in the USZ are the birds-eye-view length and width of the attached materials.

Habitat logs with attached root-wads generally don’t have to be entered in the Conservation Calculator. You should discuss the site-specific function of habitat logs with one of the Service’s project biologists. Depending on the site-specific scenario, the NOAA biologist will evaluate whether the amount and type of material anchored may function like a replacement bulkhead. If this is the case, materials anchored to the existing bulkhead toe may be entered as a replacement bulkhead.

Staircases on Bulkheads

Impacts to habitat caused by replaced or new solid-structure[22] staircases are similar to the adjacent bulkhead because the stairs, themselves, also function as a bulkhead. Staircases that are in line with a bulkhead (i.e., not extending waterward) are simply added to the total linear feet of the bulkhead.

If stairs extend waterward of a bulkhead, either parallel or in another configuration, we expect additional adverse effects from the footprint of the stairs and landing. In that case, enter the entire bulkhead in the *ShorelStab* tab (if it is being replaced) **and** the length and width of the protruding stairs as a boat ramp in the *BoatR, Jetty* tab.

Stairs that are inset landward of the bulkhead eliminate slightly less habitat than the adjacent bulkhead. This may be accounted for in different ways. The stairs may be entered separately (in a new *ShorelStab* tab in a different calculator) as a bulkhead with a reduced horizontal beach slope distance. Alternatively, both the stairs and bulkhead can be entered as a single bulkhead, the total linear feet (bulkhead + stairs) is then entered with an averaged horizontal beach slope distance based on a weighted horizontal distance accounting for the stair inset.

> Example – A concrete bulkhead of 50 feet (total) will be replaced. The horizontal beach slope distance from the bulkhead toe to MHHW, as determined in the *InputShorel* tab, is 8 and the horizontal distance from MHHW to HAT, also determined in *InputShorel* tab, is 15. The bulkhead has a 5-foot section with an inset stairway. The stairway is inset such that 3 feet of exposed beach exists from the bottom step out to the bulkhead wall. The bulkhead (sans stairs) may be entered separately as a 45 linear foot bulkhead with the site-specific horizontal distances (8 and 15). The 5-foot stairwell can then be entered in Calculator #2 as a 5 linear foot bulkhead with a reduced horizontal distance between the toe and MHHW (5 and 15). Or, the total wall (including stairs) can be entered as 50 linear feet with a weighted average of horizontal slope distances (between the toe and MHHW) between these pieces. ((5x5) + (45x8))/50 = 7.7

Tab 7: MDredging (Maintenance Dredging)

- The Conservation Calculator currently does not evaluate new dredging/deepening.
- The zone (LSZ or DSZ) is determined by the depth of the existing habitat, not the proposed dredge depth.
- The SAV scenario is usually 0 (zero) for maintenance dredging as very little to no SAV grows in areas frequently disturbed. While maintenance dredging could extend the

[22] Meaning water is not able to flow freely under the staircase. Solid structure staircases are typically rock or concrete, but may be wooden.

duration for which SAV cannot establish, it is usually too speculative to address what type of SAV might be present in the absence of dredging. However, if SAV establishes between dredging, the respective SAV rating should be entered as before condition. Further, if dredging clearly interrupts an eelgrass bed or SAV, then the SAV condition from the surrounding area should be used.
- Credit/debit factors apply to maintenance dredging.
- The Conservation Calculator considers impacts on SAV, sediment quality and forage, and the shallow water migratory corridor to last a combined average of three years.[23] Thus, for multi-year dredge permits, impacts of dredging should be evaluated for every dredging event. This can be done via either summing up the dredged area over the multiple dredge events and entering that sum into the *MDredging* tab or duplicating the dredging tab and entering each dredging event in its own tab.

Tab 8: BoatR, Jetty (Boat Ramps and Jetties)

- Enter the SAV scenario as noted in the *General Information* section below and in the *Reference* tab of the calculator.
- Use this tab to calculate credit for removal of concrete, rubble and debris.
- Credit/debit factors do apply to boat ramp, jetty and rubble removal work.

Marine Rails

Marine rails resting on the sediment should be entered in the *BoatR, Jetty* tab. Enter the square footage of the solid metal rails as viewed from above (not the open space in between) as a boat ramp. If the square footage of the rail is unknown, use a default of 1 square foot for every 1 foot of length of the two parallel marine rails (based on measurements of terrestrial rails, see Figure 19). For example, if a marine rail system is 50 feet long and 8 feet wide, enter 50 in the length of the boat ramp to be removed field and 1 (2* 0.5 ft) in the width of the boat ramp to be removed. Enter the area of concrete footings and/or stub piles associated with the rails in the *BoatR, Jetty* tab under concrete footings.

Elevated rails should be entered in the *Overwater Structures* tab. Enter the length and width of elevated rails as a solid pier.

[23] The effects of removal of sediment and invertebrate prey usually extend over two years (Boese et al. 2009, Dethier and Schoch 2005; Jones and Stokes 1998; McCabe et al 1998).
Maintenance dredging occurs at regular intervals; depending on the location every two to five years (pers. com Daniel Krenz, 2020). After dredging, the dredged area starts to silt back in and the habitat functions of the migratory corridor gradually increase. We chose a conservative impact duration for the reduction in migratory corridor function of four years.The average impact duration of three years used for the HEA analysis is based on these two time horizons.

Figure 21. Rail Width

Tab 9: Beach N (Beach Nourishment)

We usually rely on WDFW expertise in determining whether beach nourishment is appropriate for the project location. We welcome WDFW input on site-specific quantities and the technique of placement.

To ensure beach nourishment is ultimately beneficial for juvenile salmonids and will generate conservation credits, the following considerations need to be met:

- Placement of beach nourishment should follow considerations detailed in WDFW Marine Shoreline Design Guidelines (MSDG), 2014.
- Beach nourishment must demonstrate appropriate grain-size profile for target species and sediment supplementation rate according to estimated sediment erosion rates for sites and drift cell reaches.
- Dumping or disposal of non-native material, dredged material, or upland fill is excluded if it does not meet grain size and supplementation rate conditions.
- When placing material in areas known to have forage fish spawning, placement will adhere to timing windows protective of forage fish.
- Place beach nourishment within 9 linear feet of a bulkhead and at 6 inches depth for each foot of shoreline armoring. This recommendation results in 4.5 cubic feet per linear foot (pers. com WDFW).
- Beach nourishment may be piled up against armoring or spread out depending on agency biologists' site-specific instructions.

- Placement and anchoring of large woody material may be required to lengthen the retention of beach nourishment to meet the benefit period used in the Conservation Calculator.
- Material has to be clean and suitable for nearshore habitat enhancement/restoration.

Beware:

- Site-specific recommendations will vary.
- Usually, we do not credit placement or beach nourishment in the “No Appreciable Drift” or “Accretion Shoreform” shore types, as shown in WDOE’s Coastal Atlas map.
- If the function of the application of beach nourishment appears to be stabilization of structure placement rather than addressing lack of substrate, the activity may not generate credits.

Tab 10: SAV Planting

To generate conservation credits for SAV planting, submit a planting plan, performance standards, a monitoring plan, and a site protection instrument where applicable with your consultation initiation package. You can find an example of a mitigation plan at: Components of a Mitigation Plan (4) site protections instrument; information on deed restrictions associated with compensatory mitigation here; and an example of a Mitigation Monitoring Report for riparian plantings can be found here.

Tab 11: Reference

The *Reference* tab provides background information including:

1) The cover categories for submerged aquatic vegetation and USZ vegetation;
2) The delineation of shore zones for the Riparian Zone, Upper Shore, Lower Shore, and Deep Shore Zones
3) Complex float length and width determination for overwater structure (OWS) tab.

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